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Examining the Evolution of the Tertiary Sector: Economic Geography of Knowledge

Economic History PhD Thesis

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Declaration

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Abstract

Economic historians tend to focus on the contrast between manufacturing and agriculture to explain development gaps, underestimating the increasing role of services that has been only marginally explored. This study provides a long-term view on geographical localization patterns of services in the USA during the 20th century, with a special focus on the knowledge intensive sector. It expands the traditional debate regarding the localization theory in the context of the service economy and provides a new dataset that delivers geographically accurate results at the level of counties. The thesis adds new quantitative evidence to the pre-existing literature on the service economy, showing an increasing and disproportional agglomeration of skilled workers in big urban areas that exacerbates the differentials between rural areas and metropolises. This trend is statistically significant at the level of counties, and possibly overlooked if broader geographical units are used. This evidence favors the New Economic Geography theory by showing a causal, positively significant and increasing impact of market size on the disproportional allocation of not only knowledge intensive services, but almost any non-agricultural economic activity, pointing at the incompatibility between increasing returns to scale and activities requiring an intensive use of land. This impact seems to be simultaneously constrained by the failure of agricultural production, unveiling that good preconditions for agricultural success prevent the development of the service economy through the persistence of agricultural agglomeration. This persistence however can be fought: evidence shows that an external shock (i.e., a new university) will not only have a positive impact on the local economy, but also on nearby counties. Moreover, the local human capital shock positively affects the whole nation while making foreign competitors worse-off. Results are persistent in the long run, although the strength of these shocks dilutes over distance and time. Such evidence points to the service economy as being the driver of regional gaps in the 20th century, effectively strengthening its importance for local and national policy-makers.

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I am definitely standing on the shoulders of giants.

Figure 1: Landmarks in the history of the United States of America

Event	Year	Total Population	GDP per capita
Discovery of the Americas by Portuguese and Spanish empires	1492		
Spanish establish first permanent European colony in Florida, (Saint Augustine)	1565		
	1600	1,500,000	
First settlement of British colonies in Virgina (Jamestown)	1607		
The Dutch settle in New Amsterdam (1664, renamed New York by the English)	1612		
Pilgrims establish the colony of Pymouth in (Massachussetts)	1620	1,383,162	
First public library in Virginia			
Establishment of Harvard University in Massachusets Bay			
Establishment of Yale University	1650	1,224,745	
	1700	1,000,000	
Age of the Enlightenment begins in Europe	1715	1,333,196	
	1750	2,608,036	
French and Indian War between French and English control of North America	1754	2,815,910	
	1760	3,159,195	
British gain control over french of Canada and all east Mississippi	1763	3,346,225	
American colonial society protests against the authority of British Parliament	1765	3,477,024	
	1770	3,826,829	
Boston Tea Party	1773	4,053,386	
American revolution starts	1775	4,211,826	
Declaration of independence	1776	4,293,354	
Industrial Revolution begins in Great Britain	1780	4,635,556	
American revolution ends: GB awards independence to the USA	1783	4,909,990	
George Washington unanimously elected presindent of the US	1789	5,508,562	
Ratification of the constitution by 9 states			
Age of the Enlightenment ends in Europe	1790	5,615,191	1,763
First slavery revolts end in tighening of the slave laws in Virginia	1800	6,801,854	1,913
Louisiana Purchase - population expansion	1803	7,204,537	1,947
Napoleonic wars between the English and the French begin			
Jeffersonian Embargo	1807	7,778,775	2,045
Anexation of British territories	1810	8,239,294	2,051
Napoleonic wars end	1815	9,068,206	2,111
Spanish empire cedes Florida to the USA	1819	9,790,987	2,023
	1820	9,980,510	2,011
Construction on the first public railroad between Baltimore-Ohio	1828	12,580,590	2,209
Nat Turner leads the biggest slave rebellion in Virginia. Stricter laws	1830	13,240,314	2,294
Start of the abolitionist movement			
	1840	17,443,768	2,512
Aquisition of Texas	1845	20,502,776	
Anexation of Oregon territory	1846	21,114,282	2,673
Mexican war			
Mexico cedes California, Nevada, Utah, New Mexico, Arizona, Colorado and Wyoming	1848	22,337,396	2,818
Gold discovered in California			
	1850	23,579,718	2,755
American Civil War begins	1860	31,838,901	3,359
South Carolina Secedes from the Union			
Confederate States of America include Mississippi, Florida, Alabama, Georgia and Louisiana	1861	32,677,742	3,288
Morrill Act	1862	33,515,609	3,394
Homestead Act allows settlers to claim land by proof of 5 year settlement	1863	34,354,509	3,618
Emancipation Proclamation ratified the illegal status of "slaves"			
American Civil War ends	1865	36,031,388	3,542
Purchase of Alaska	1867	37,708,378	3,632
Fifteenth Amendment gives blacks right to vote	1870	40,240,630	3,971
General Mining Act is approved	1872	42,136,000	4,106
National American Woman Suffrage Association is founded	1890	63,302,000	5,525
US annexes Hawaii	1892	65,922,000	5,717
The Gold Standard Act is passed in the US	1900	76,391,000	6,624
Wright brothers make first controlled, sustained flight	1903	80,946,000	7,356
	1913	97,606,000	8,449
Great War starts in Europe	1914	99,505,000	7,616
Panama Canal opens to traffic			
First long distance telephone call (New York to San Francisco)	1915	100,941,000	7,759
Great War ends	1918	104,958,000	9,255
League of Nations first meeting	*1919*	105,473,000	8,908
Ninenteenth Amenment of Consitution grants female vote			
The Great Depression	1929	122,245,001	10,387
New Deal	1933	126,180,000	7,268
Second World War starts in Europe	1939	131,539,000	10,225
US drops atomic bombs in Japan	1945	140,474,001	17,615
Second World War ends			
United Nations is Established			
Marshall Plan	1947	144,688,000	14,932
Cold War tensions begin			
North Atlantic Treaty Organisation	1949	149,770,000	14,866
American troops commit to Korean war - cold war conflict	1950	157,813,040	15,856
Vietnam War	1953	165,260,027	17,471
	1960	186,326,215	18,175
Cuban Missile Crisis	1962	191,953,977	18,978
	1965	199,452,508	21,210
President Kennedy and Martin Luther King are assasinated	1968	205,672,499	23,268
US abandons The Gold Standard	1971	211,355,530	23,745
Oil crisis	1973	215,164,616	25,742
American troops leave Vietnam	1975	219,108,358	24,890
	1979	227,624,232	28,279
	1980	229,825,005	27,838
	1990	253,339,096	33,710
End of the Cold War	1991	255,807,342	33,077
Persian Gulf War			
President Clinton signs North American Free Trade Agreement into law	1993	260,803,255	33,915
	1995	266,323,718	35,053
Dot-com Bubble Begins	1997	272,643,339	36,848
U.S. and China sign historic trade agreement	1999	279,300,030	38,913
Dot-com Bubble ends	2000	282,496,311	39,758
Islamic Attacks on New York	2001	285,544,779	39,474
Iraq War	2003	291,290,824	40,044
	2005	296,820,296	41,674
	2006	299,564,470	42,379
Global economic crisis begins: Dow Jones decreases 4.4% in one day	2008	304,989,065	42,227
Barack Obama first black president elected			
	2010	310,383,948	41,231

GDP per capita expressed in Purchasing Power Parities (in international dollars, fixed 2005 prices). *Source: Population data from Maddison (2007) with interpolations from Lindgren, M. (Gapminder Organisation) and UN Department of Economics and Social Affairs (2010). GDP data from Lindgren, M. (Gapminder Organisation) and Barro and Usua (2008): "Macroeconomic crises since 1870", Frankema et al. (2010): "Comparing productivity in the Netherlands, France, UK and USA, ca 1910: a new PPP benchmark and its implications for changing economic leadership" and the IMF (2013): "World Economic Outlook Database".*

Part I

INTRODUCTION

CHAPTER 1

The US and Economic Historical Geography in context

Motivation

During the last century, the United States of America achieved world leadership by adapting its productive structure to international demand. This commercial success has increased standards of living, but has created regional gaps as well, not only between the nation and other parts of the world, but also within the country. Many authors point at productivity and skill premiums as the cause of these regional differentiations (see Autor et al. [2008] and Moretti [2012]). The study of agglomeration and localization of production seems reasonable to explain growth and development, trade or regionalism. As the origins of development gaps are postulated to be found in the era of industrialization, the norm has been to study the secondary sector in contrast with agriculture. More specifically, the 'manufacturing belt' has been the paradigmatic case for the analysis of employment concentration (Krugman [1991], Kim [1995], Crafts and Klein [2012]).[1]

[1] The same framework has been used to explain why some territories are more developed than others within other countries, like Rosés [2003] and Maurel and Sedillot [1999], at a regional level like Brülhart and Torstensson [1998] and even worldwide like Redding and Venables [2004] and Ottaviano and Puga [1998].

Manufacturing has become somewhat less important for developed economies: Leading economies have progressively shifted their employment structure from 36-40 per cent of service production in 1890 to around 80 per cent in 2010 (Table 8). However, the service sector has not been the subject of study until very recently. Ciarli et al. [2012] defend the importance of Knowledge Intensive Business Services as a source of growth in Europe and its localization close to big markets. Furthermore, Moretti [2004, 2012] shows the relative increase of very skilled service employees that have turned the manufacturing belt into a 'rust belt' by shifting the core of the US economy from the centre to the coast, close to the biggest metropolitan areas. Figure 1.1, shows the percentile distribution of mean income across US counties, revealing several facts about regional discrepancies in 2010:

1. The mean wage distribution is extremely unequal across counties: it ranges from a minimum of $26,559 per year in Hancock (Georgia) to $109,405 per year in New York.

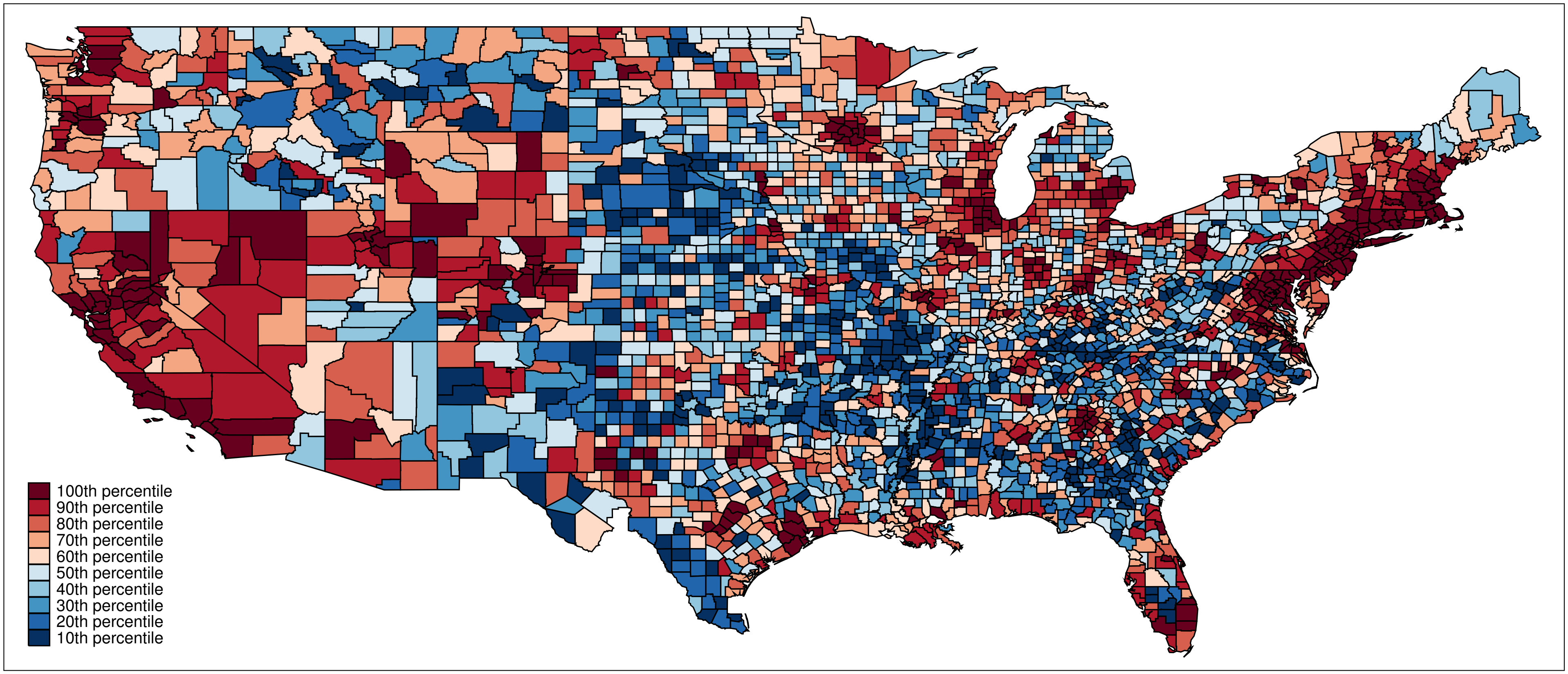
2. The lowest income counties are concentrated in the centroid region of the country. In fact, most counties above the 50th percentile ($44,391) are located on the coast.

3. There are four prosperous hotspots across the US map: the west coastal region (California, Nevada and Washington that seem to have a spread effect in Oregon, Wyoming and Colorado), the state of Florida and the former 'manufacturing belt'.[2] These areas are not only characterized by high earnings levels, but also by being the most populated regions during the 20th century.[3]

[2]According to Crafts and Klein [2012]: "the term 'manufacturing belt' has long been used to describe the remarkable spatial concentration of industry in the United States that prevailed from the third quarter of the 19th to the third quarter of the 20th century. (...) states whose territory is wholly or predominantly in the manufacturing belt are Connecticut, Delaware, Illinois, Indiana, Maine Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia and Wisconsin."

[3]Excluding Florida, whose categorization as a big city starts in 1930, the main cities of the productivity hotspots belong to the either the US Census ranking of the 100th most populated cities or to the Standard Metropolitan Areas (SMA) classification.

Figure 1.1: Mean income per county, 2010



Source: own calculations from America Community Survey (2010).

This transition from successful manufacturing cities to highly skilled service urban clusters in the biggest world economy motivates the analysis of industrial localization and specialization patterns. There are more practical reasons that make the analysis of the United States relevant. A major share of the empirical analysis on spatial economics is based on the United States of America. Moreover, the historical records provided by the US Census are very rich, and the big size of the country and its compartmentalization provides not only an opportunity to study the nation but also to undertake a more regional analysis of counties, regions and cities that may not share institutions or legal frameworks. This layered analysis allows for the discernment of different patterns to infer conclusions for other countries, regions and even more local units of analysis (counties or cities).

The central premise is that service sector employees are distributed following two trends:

1. Personal and distributional services are predictably allocated in proportion to population, which justifies the low interest of academics in the empirical analysis of this industry (Broadberry and Ghosal [2002]).

2. A high percentage of Knowledge Intensive Services is provided to intermediate consumers (firms) and are characterized by being storable. A relatively higher knowledge intensity makes these services more interesting from the empirical point of view: the easy spread of information involves externalities on information-intensive sectors and attracts the overall economy in greater proportions.

Economic Geography in the 20th century

Economic geographers seek an explanation to the concentration of the economy at different geographical layers. The unequal distribution of the economy can be approached from different perspectives, from the global North-South divide and regional differentials in the core-periphery model to local clustering of competing businesses and industrial districts to rural-urban growth processes and within-country disparities. Such perspectives tend to yield general equilibrium results, but are micro-founded in the sense that individuals and firms consider the costs and returns of relative factor endowments, including transportation costs.

The history of economic geography may date back to the inception of location theory during the 19th century, but the recent efforts of well-known economists like Krugman [1991], Combes et al. [2008], Fujita and Thisse [2013], and Epifani [2005], who have formulated a theoretical base on the assumptions of increasing returns to scale, have underscored the importance of the role of economic geography in the wider discipline of economics. This trend has revealed the complex multifaceted relationship between physical distance and economic activity (Rodríguez-Pose [2011]). The role of historical economic geography is much more recent and limited. First, because economic historians, who tend to explain contemporary differentials of economic growth based on past economic and social causation, rely on cliometrics (past data to explain present outcomes) and require the use of economic models that have been properly specified only recently. Second, because it involves the participation of a rare breed of scholars who seek to explain contemporary economic circumstances based on the past location of industries, effectively adding a new variable to the classical economic history view. The traditional 'what' explains 'how-much' approach is extended by economic historians by adding the 'when', and by geographical-economic historians by seeking the 'where' to explain the 'why'.

Economic historical geography is complex: social science merging the arguments of economic geography and economic history to explain long-term geographical differentials at local, regional and global levels. Economic geography is multidisciplinary: the discipline takes from international economics, development economics and industrial economics to analyse different geographic trends.

The origin of location theory dates back to the school of German economists pioneered by Von Thünen who, using contemporary theories (Ricardian and Malthusian rents theories), inspired the future of international trade and spatial and urban economics theory by designing the model of the Isolated State in 1803 (Samuelson [1983]): a city surrounded by concentric circles of agricultural land with different uses, and a linear distribution of productivities and rents that would affect the free movement of labor and the price of manufactures and agricultural products based on iceberg transport costs.

As Samuelson [1983] pointed out, this early model already hinted at the concept of increasing returns to scale leading to the agglomeration of population in towns later defined by Marshall [1898], by which the agglomeration economies (a big pool of labor, linkages and knowledge spillovers) overcome the dis-economies or costs of living in congested areas (pollution, higher rents, commuting, etc.). The tensions between Marshallian economies and dis-economies set the basis for the further growth of cities and determined a landscape of several isolated states including models that are no longer dual (agricultural and non-agricultural).

An extension from this self-sustained growth of cities came from the urban economics field. Jane Jacobs [1970] proposed that cities attract laborers not only because of agglomeration economies, but also thanks to the economies of diversification that exacerbate the effect of size and diversity to the process of innovation. In her view, the dynamism of big cities is expressed by the observation that good ideas spread across different sectors. The more heterogeneous the city is, the further it will grow. This process is, of course, self-enforcing.

The role of knowledge seems to be a persistent matter when determining the disproportional allocation of population in geographical terms, leading to the recent concept of the smart city by Glaeser et al. [1991], who envision the kind of city that manages to obviate dis-economies of agglomeration, ensuring the growth of the quality of life of its inhabitants (Shapiro [2006]). All these knowledge spillovers are particularly relevant for the kind of goods that cities have a comparative advantage in producing (high value services with low transportation costs), which lead to even higher returns thanks to the so-called 'death of distance'.

The founders of New Economic Geography (Fujita and Krugman [2003]; Venables [2001]) did not create a new theory, but managed to emphasize the role of increasing returns by modelling it through a monopolistic competition production function (Dixit-Stigitz, 1977) that escaped from the traditional constraints of perfect competition and constant returns to scale. Many traditional economic geographers were offended by their intention to differentiate themselves, disputing the novelty of their framework. As argued by Fujita and Krugman [2003], the novelty was simply to revisit economic geography by providing a methodology that was very well accepted by mainstream economics.

As is common in economics and science more generally, the complexity of geography leads scholars to make assumptions. As Marshall [1898] observed:

> "*Economies of massive production are of many different kinds* {. . .} *each of these different kinds has its own method of affecting both the national and social issues in question.*"

Thus, different economies of scale must be analyzed with different strategies and some criticize these as leading to biased results.

Oversimplification, however, may not be a problem if the strategy of analysis is relevant for the nature of the clustering. As Fujita and Krugman [2003] argued in their review of the discipline, international, urban and regional models are based on similar assumptions, but may emphasize the relative importance of one or another feature.

The core-periphery model is based on a simple two-factor, two-region and two-sector model that evolves from the traditional Hecksher-Ohlin configuration used in international economics including both product differentiation and transportation costs. One of the sectors produces at constant returns (typically, agrarian products) and the other sector produces a range of differentiated substitutable manufactures that consumers can choose from depending on the price they get from the market and their location: this is the simple outline of increasing returns. In this framework, the main constraint on mobility comes from the constant returns sector that forces producers to stay close to the input (farmers to arable land), pushing manufacturers away with a 'centrifugal force'. The region that welcomes manufacturers grows even more thanks to the 'centripetal force' allowed by the monopolistic power of their differentiated product. This design may lead to two unequally distributed regions depending on the degree of transport costs, the differentiation of the goods and the relative size of the manufacturing sector.

The evolution from the core-periphery dual simplification was achieved by implementing the linear distribution of land across several manufacturing locations surrounded by agrarian regions, exemplified by Von Thünen's location model. In this framework the thickness of the market, usually measured through Market Potential (Harris [1954]), is what determines the relative strength of the pull and push factors. An alternative class of models considers the possibility that externalities spread across firms within the same sector and not only within the firm. This explains the formation of industrial clusters and requires a little bit more of visibility in terms of industries.

Although the models are different, they do in fact examine the same idea with different assumptions. It may be limiting to rely on a single model that restricts the ability to grasp all the facts relating to agglomeration. An examination of New York can lead to many interesting questions in light of localization: why does New York produce such a great amount of services? Are these provided to New Yorkers or to the whole country? Why do most of the firms concentrate in Manhattan? Are all the firms on the island producing the same kind of goods? Why does Brooklyn exist? Does this count as diversification? Why is the Bronx poorer than the rest of the city? Can we find as many poor people as in Detroit? Or as in Valley Falls (Kansas)? Can we compare this inequality with the one we find in Tijuana (Mexico)? Recent models tend to overlap these views and show that both endowment and agglomeration forces induce the patterns of specialisation and trade. In particular, Epifani [2005] shows that the interplay between factor proportions between trade partners and agglomeration forces explain the simultaneous rise in production specialization and the fall in trade specialization experienced in the last few decades. This view accords with the evidence that Yamamoto [2007] put forth for the nested-regions nature view of American markets and posits evidence in favor of the potential development spillover effects of local projects on regional development (Pike et al. [2007]).

Economic historians are interested in economic inequality and development gaps, evident from the perspective of urbanization and the city. The science that explains the income gap between a city and a village seems to be able to explain when the trend started with sufficiently good data and even why. Economic geographical history (or better said, new economic geographical history) may provide yet a better answer. For example, one can envision the growth of New York as a city of services thanks to the success of its port and the high income of its merchant population (Glaeser [2005b]). This new science can provide insights into how to improve our living standards, whether we live in a smart city, a declining urban area or a village in a developing country.

Outline

The previously mentioned productivity hotspots represent a greater percentage of services in their labor distribution. The key question is whether the unequal configuration of the market across geographical space has something to do with economic fundamentals like relative factor quantities and prices and whether policy makers can do something to redistribute regional growth prospects. In order to provide answers to these questions, I first describe the historical context of the American economy. I present an extensive description of employment patterns by county in Chapter 3 through which it becomes clear that the knowledge economy is behind the success of the American economy in the last century. Chapter 4 presents a model that determines the regional localization of knowledge clusters, where it is shown that economic geography matters, but the pre-industrial success of agricultural production and path dependency can have a great impact on the contemporary configuration of unequal development. This, however is not the ultimate result of a multiple-equilibrium model. As shown in Chapter 5, local and regional policy-makers can find a way to counteract the equilibria reached through economic fundamentals by changing the configuration of mobile factors of production such as labor; I show that the share of skilled workers can expand the local Production Possibility Frontier. Chapter 6 concludes.

CHAPTER 2

The turning of the US into a service superpower

"Ours are the only farmers who can read Homer."

Thomas Jefferson, 1787

This chapter reviews the economic history of the United States during the 20th century, emphasizing its development into a service economy. The chapter first explores the country's transformation from a land of equal opportunities into an unequal country through the role of institutions. It then shows that unequal growth created long-run geographical inequalities. Finally, it argues that regional differentials are derived from specialization patterns in urban service economies. Early US leadership might have been based on natural resource abundance, but it was perpetuated thanks to a process of socially constructed innovation through institutional, technological and organizational rules that expanded the American market nationally and internationally enabling economies of scale. Crucial as it is for manufacturing, the proximity of markets has been key in preserving the leadership of the US in the market for knowledge services over the last century.

JEL classification: N00, N72, O4.
Keywords: United States, Services, Growth.

2.1 Introduction

Economic historians tend to explain the success of the United States as a history of manufacturing, where vast natural resources and immigration justified the breakthrough of mass production. This reasoning was persuasive when manufacturing represented a fourth of the US economy. From the 1950s to the 21st century, however, the share of manufacturing in total GDP has declined to less than a tenth of Value Added today, while the service economy accounts for more than half of the Gross Value Added produced in the US today (Timmer et al. [2014b]). In this course of events, economic historians should reconsider writing the history of the United States as that of a pioneer of the service economy, reflecting urbanization and human capital as the key ingredients of the success of mass production.

According to Glaeser [2005a] four factors fostered urbanization -and the rural-urban breach- in the mid-19th century: increasing agricultural productivity, manufacturing technologies, transportation and the related rise of immigration. The remainder of the chapter describes how the country became the engine of the world economy by first explaining the transformation from a land of equal opportunities to a state of unequal growth through the role of institutions; then, it explores how unequal growth created long-run income inequalities, to finally show that these gaps correspond to urban service economies. In sum, the transformation of the US economy can be explained through the change of institutions, economic structure and path dependency, but above all, this success results from the extraordinary ability of the American labor force to exploit and transform available resources in a successful way, termed 'social capability' by Abramovitz [1986].

2.2 Growth, productivity and institutions

US Census population estimates report a total count of barely 2,300 Europeans and around twenty African slaves in the original colonies of the United States of 1620. The Virginia and Massachusetts bay areas met the requirements of English investors: permanent locations had to be surrounded by water but far inland to prevent possible attacks; the coastline had to be deep enough to tie ships at the shoreline, and preferably unoccupied by a native population to avoid initial conflict. In Jamestown and Plymouth, population growth was faster than today's; by

1740 population had grown by a million even accounting for the devastating effects western diseases had on the native population. Overall, pre-revolutionary population growth represented around 3.5 per cent per annum, while today population grows less than one per cent according to Atack and Passell [1994].

The intentions of colonizers involved mainly land exploitation and trade.[1] The economic performance of European colonies varied widely across the New World. The colonies that later became the founder States achieved similar living standards to their motherland while they were still colonies; other former colonies in the New World are considered developing economies still today. Recent consensus points to colonial institutions as the origin of the long-run divergence between Spanish, Portuguese, and English colonies (Sokoloff and Engerman [2000]).

The initial prospects of the English were way too optimistic: more than half of the early English colonizers died within a year, the expectation of the discovery of large silver and gold deposits following the Spanish and Portuguese experience were soon forgotten. Moreover, crops in the Newfoundland did not behave as they had anticipated. The eventual discovery of tobacco reignited the commercial interests of English settlers who pushed the vast frontier plantations to the limit. However, output per capita was almost stagnant, growing at an average annual rate lower than two per cent. In other words, the colonial economy was based on extensive growth that was maintained in the long run through the different waves of land acquisition reported in Figure 2.1.

American agricultural goods like tobacco, cotton and rice flooded international markets, but the market value of these goods was sustained thanks to inelastic international demand, low production costs due to economies of scale and cheap slave labor ([Atack and Passell, 1994, Ch.2]), which ensured a high volume of production. By that time, the first settlements (including New York and Boston) became important port cities thanks to good water transportation conditions and economies of scale. These allowed reasonable costs for distribution fostering progressive population growth that led to the paradigmatic dynamic metropolises they became in the last century (Glaeser [2005a,b]).

[1] A few of the early colonizers were motivated to move to the New World to find religious freedom. These were later known as Pilgrims: English migrants in Holland that ended up moving away from Europe in fear that the new Dutch life-style was spoiling their English heritage.

Figure 2.1: US inland territorial acquisition since British Colonies unification

Source: Divine et al. [2002].

As mentioned by Glaeser, agricultural productivity growth was one of the first phases toward urbanization. Thus, population growth was partly driven by the discovery of ‘cash crops‘. Initial settlers eventually became landlords and required labor to extend their wealth. This demand for labor motivated relatively high wages that attracted further Europeans even if they could not afford the cost of the passage. Indenture contracts paid for the trip in exchange for their labor input during a specified period. Additionally, the British slave trade reached its peak in the 17th and 18th centuries, bringing a total of 2.5 million Africans to the Americas from Sierra Leone and the Upper Guinea coast, mainly in the southern colonies, where tobacco and cotton plantations were fruitful (Maddison [2001]).[2]

[2]Slavery was common in the southern states until 1863, when president Abraham Lincoln issued the *Emancipation Proclamation*.

By the end of the 1760s, trade had allowed second and third generations of settlers to enjoy a gradual increase over subsistence production and generated an initial income gap within the American population: New England consisted of a modest elite of tenants and merchants who lived luxuriously and a middle class of farmers and artisans who managed a modest but secure income. Decent social prosperity fermented the germs of the Revolution through the profound disagreement of the colonial population with British institutions such as the *Navigation Acts*. These conflicts represented the tension between the needs of a fast growing economy and the effort of Great Britain to preserve its commercial power in the 18th century. The 'Patriots' broke the link with colonial governments through the control of Boston in 1775, starting an institutional reform that began with the transformation of the Thirteen Colonies into independent States and the suppression of any form of European power.[3] The draft of the *Declaration of Independence* was unanimously adopted by the states marking the birth of a new nation that called itself the 'United States of America'.[4]

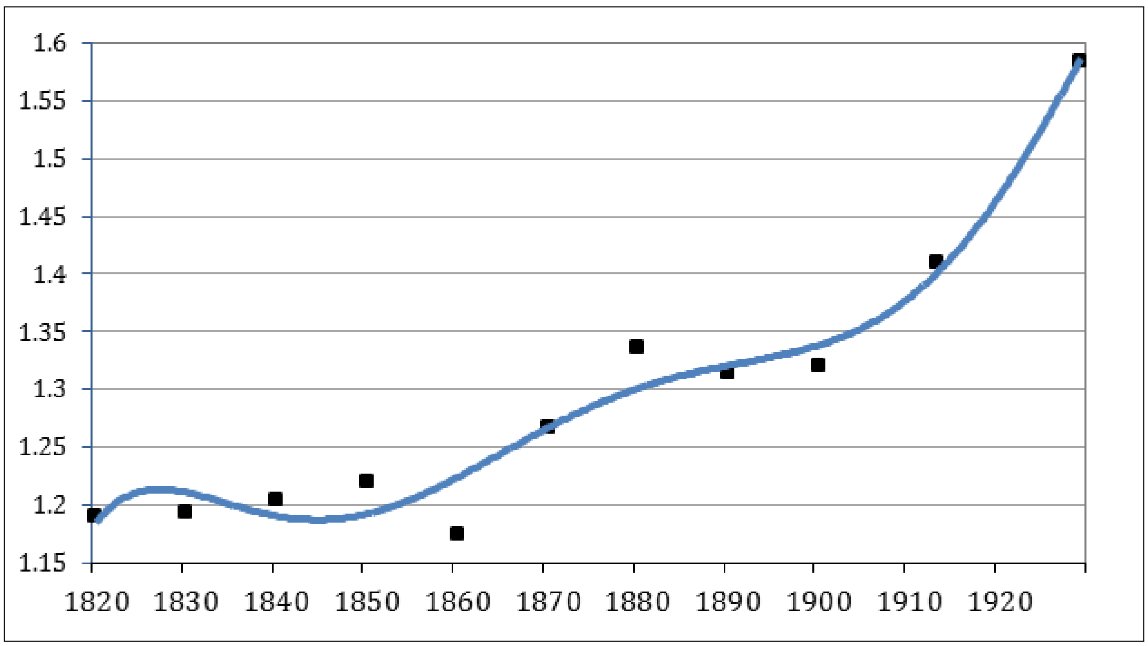
Consistent with the feudal legal framework still present in Europe, all English colonizers were the King's tenants on their land. European traditions of land transfer rights were crucial for the natives, who had no custom of private property, but only 'occupancy' rights. The colonial land was gradually crowded with settlers with land rights that ensured perpetuity and inheritance rights to preserve outright ownership to latter generations of settlers. This granted relative equality that contrasted with other European colonies where power was much more concentrated among privileged elites. According to Maddison [2001], institutional and societal policies transmitted by different colonizers determined the remarkable economic growth differential between the US and its neighbors: while Spanish colonies were mainly draining resources to the metropolis, the British colonial regime imposed mercantilist restrictions on trade, but to a much lesser ex-

[3]The Thirteen Colonies included: New England (New Hampshire; Massachusetts and Maine; Rhode Island and Providence; Connecticut), the Middle Colonies (New York; New Jersey; Pennsylvania; and Delaware), the Southern Colonies (Maryland; Virginia, West Virginia, and Kentucky; North Carolina; South Carolina; and Georgia, Alabama and Mississippi).

[4]The 'Patriots' were also known as 'Rebels' with different social backgrounds (intellectuals, merchants, farmers). They were led by a well educated group of New England citizens, including Statesmen like Thomas Jefferson who rebelled against British control. Their motto was 'No taxation without representation!' referring to the non-existent representation of their rights in Parliament. One of the first rebellions consisted of the organization of the Boston Tea Party, where they dumped 45 tons of tea cargo from three British ships, unleashing the American Revolutionary war.

tent. After unification, agriculture still engaged 90 per cent of the labor force and trade constituted the main source of ('Smithian') growth until the early 19th century, when the US withdrew from international trade with the contenders of the Napoleonic wars (the French and British Empires). The effects of the 'Jeffersonian' embargo in 1807 reduced GNP by five per cent according to Irwin [2005]. This collapse, together with the soil depletion that farmers were suffering, was critical for the US economy, whose balance of payments did not recover until the 1830s according to North [1961].

Figure 2.2: Per capita income of US with respect to the average of Great Britain, France and the Netherlands, 1820-1929.



Source: Prados de la Escosura [2000].

Economic historians consider the 1830s the turning point, when the country pivoted away from agrarian production to industry, or the '*take-off into self-sustained growth*' (Rostow [1956]). Note that GDP per capita started to increase with respect to British standards from 1860 onwards according to Figure 2.2. Intensive growth started with an increase in agricultural productivity which led to a sharp decline of the agricultural labor force from 83 to 63 per cent from 1840 to 1880. According to David [1967], the surplus of agricultural workers was attracted to higher productivity sectors: a light manufacturing sector (mill industry) and a heavier manufacturing industry (mostly shipbuilding). Many others transferred to personal services or joined the sizeable merchant marine. Bairoch [1982]'s data shows that total industrial production in US surpassed that of Great Britain between 1880 and 1900. The United States took over British leadership in manufacturing thanks to labor productivity growth in manufacturing activities associated to natural resources (namely, mining and energy) that were relatively more productive in the United States by the 1870s according to Broadberry [1998].

Table 2.1: Labor productivity in the secondary sector of the US and Great Britain

Sector	**1870**	**1910**	**1929**
Mining	103.1	162.0	248.9
Manufacturing	182.5	202.7	250.0
Construction	95.5	198.5	133.7
Energy	55.8	149.5	335.9

Great Britain = 100, *Source: Broadberry [1998].*

The role of comparative advantage seems crucial to the path of specialization taken by the US. Wright [1990] estimated that natural resources were the biggest source of comparative advantage from 1877 to 1940. On the eve of the Great War, the USA was responsible for 95 per cent of worldwide production of natural gas and 65 per cent of petrol extraction according to the records of the US Geological Survey (Wright [1990]). The US held an advantage due to the amount and variety of minerals they owned in a period where minerals were costly to transport and crucial for manufacturing. However, David and Wright [1997] point out that US supremacy was not the result of natural resource advantage because US production was much higher than its share of world resources. Instead, it was a socially constructed situation driven by the adoption of new technologies of extraction.

Wright [1990] also proved that the key was the incentive structure provided by the exceptionally liberal mining law. The *General Mining Act* of 1872 formally granted open access for exploration and exploitation rights subject to proof of having discovered a mine, whereas in most countries the state held the property of mineral resources.[5] The initial expectations of first colonizers were finally met

[5] Prior to this Act, miners governed themselves informally. The distance and the small size of exploitations avoided conflicts among miners. However, this situation changed with the first wave of gold-diggers in 1849. Miner density grew and conflicts were recurring and violent. Eventually, miners institutionalized mining towns, controlling and regulating access, exploitation, registry and trespass deposits.

when the Mining Act provided the incentives that prompted the 'gold-rush'. In 1848, the number of gold-diggers increased from 5 to 40 thousand in a year to a maximum of 100 thousand in 1852. In the process, gold diggers discovered other useful minerals like copper and coal in Michigan, Pennsylvania and Indiana.

The success of mineral extraction led to the investment in mining education that served to develop an engineering culture not present in the old continent. Scientifically trained workers were crucial for the expansion of the knowledge of mineral uses. The role of higher education and training was crucial to the metallurgy revolution and, eventually, for technological advance.

The success of the mining industry also motivated the westward expansion of the country: two weeks after James Marshall found gold in California, the USA obtained the territories from Mexico. The expansion which led to the second take-off phase of self-sustained growth resulted from the railroad diffusion to the Middle West in the 1850s (Rostow [1956]). The investment needed to develop the railroad network was not only economic, but also institutional; coordinating the huge flow of trains between the different geographical divisions was vital.

These institutional and organizational changes led to the reform of the US entrepreneurial system into the more complex structure associated with managerial capitalism. According to Chandler [1990], this structure diffused from the pioneering railway companies to other sectors through the modification of traditional systems of business management. Railroad diffusion enabled cheaper trade and increased specialization, driving the growth of other sectors and also increasing productivity. Atack and Margo [2011] estimate that the effect of the railroad accounts for an eight per cent increase in average farm productivity nationwide, and the rest to actual transport cost reductions and specialization.

As Crafts [2010] points out, productivity increases were a consequence of capital deepening only until 1890. From the late 18th century onwards, Total Factor Productivity represents 73 per cent of the increase in labor productivity, reaching 95 per cent in the period 1929-48. In the early 20th century, natural endowments, labor and capital investments did no longer contribute to economic growth. Instead, skills, institutions, organizational improvements and the development of general-purpose technology were at the heart of US economic growth. These can be illustrated with the example of Taylorism and the development of electrification put into practice in the biggest successful companies that provided industrial products at the beginning of the century.[6] Skilled labor force was able and eager to adopt and develop new technologies to increase production enabling a world technological leadership backed by human capital so extraordinary that it became 'the secret of the American success' during the 'Human Capital Century' (Goldin and Katz [2009]).

2.3 Regional inequality: mobility and urban growth

Sustained increases in GDP per capita travelled alongside most indicators of well-being during the century. However, disparities have become larger over time. Those with a previous advantage are better off today: Connecticut, New Jersey, Massachusetts, Maryland and New York rank at the top of income per capita; while Mississippi, New Mexico, Arkansas, Utah and South Carolina remain at the bottom of the distribution. There seems to be a geographical pattern among the richest counties which correlates with early colonization. The US Census reports significant differences in the median levels of household income between those at the North-East and West and those at the Midwest and South.

A large section of the literature deals with regional inequalities as a result of regional specialization patterns. In the context of the United States, Crafts and Mulatu [2005] show how factor endowments played a role in industrial location decisions prior to the 20th century, these being usually determined by relative factor prices and a constrain force of fixed (immobile) factors. Where there was a relatively large endowment of land, agricultural production was successfully adopted generating a trend of path-dependence. However, the role of transportation is crucial to trade, and the reduction in communications and transportation costs altered the mobility and prices of labor and capital, changing the specialization patterns of those which had no prior advantage. This change reversed the relatively higher importance of factor endowments that lagged behind the size of the market for all those industries enjoying economies of scale.

[6] David and Wright [2003] point out that these advances 'were not simply matters of technology, but also reflected political and institutional changes that allowed utilities largely to escape regulation by municipal, town and governments, facilitating the flow if investment capital into holding companies presiding over centrally managed regional networks'.

Individual inequality has also increased since the 1940s. In the 1970s the top five per cent of the population received 16.6 per cent of the income and the bottom five per cent received a mere four per cent; today, the top receives around 22 per cent and the bottom 3.4 per cent.[7] Cross-industry comparisons show that individual inequality can also be explained through industry specialization. The return to schooling was similar for blue and white-collar workers until the 1940s when the supply of jobs that previously required no extraordinary skills before arose: sales-personnel had to be able not only to sell, but also to explain the mechanism and install radios, refrigerators, and later on, computers. Thus, counties with a high share of skilled employment had attracted many more skilled jobs by the 1980s, raising the wage differential between the skilled and the unskilled (Moretti [2004]). The counties where knowledge intensive sectors clustered received higher salaries.

The return to education was high at the start of the century, declined until the 1940s and increased again from the 1950-70s. The last quarter of the century was marked by a slowdown in the rate of growth where post-graduate education returns were markedly higher. This coincided with a period of modest economic growth that was unequally distributed. Goldin and Katz [2009] show that the key to this inequality comes from skilled biased technological progress that accelerated the demand for highly skilled workers, in particular within the service economy where capital and skills are complementary; this increase accompanied by the slowdown of schooling trend has enlarged the gap.

The long-term tradition of mass higher education was at the heart of American success until the 1980s, but technological progress has increased the gap between rural and urban regions crowded with skilled labor; in particular, 'smart cities' or 'knowledge hubs' have proliferated since the 1980s, exacerbating the unequal spread of growth. Specialization of the cities in skilled sectors matters; as Moretti [2012] observes:

[7] Goldin and Katz [2009] report there was a narrowing of the wage structure during the 1940s, termed the 'Great Compression'. It was caused by the involvement in a world war, inflation, tight labor markets, rising union strength and government intervention. The returns to education were higher in 1914 that in 1939 according to their calculations, the decrease in the return coincides with the expansion of education.

> *"Today there are three Americas. At one extreme are the brain hubs - cities with well-educated labor force and strong innovation sectors. They are growing, adding good jobs and attracting even more skilled workers. At the other extreme are cities once dominated by traditional manufacturing, which are declining rapidly, losing jobs and residents. In the middle are a number of cities that could go either way."*

Again, the key behind this disparity comes from skilled biased technological changes, which have clearly contributed to skill and skill premium gaps, and the specialization patterns of counties reflect these in their aggregate average wages. However, General Purpose Technology (GPT) has also had an impact on these gaps. The effect is more subtle because GPT technology affects a large segment of the workforce not particular to any firm or sector. GPT is relevant to overall economic activity, being pervasive, omnipresent and quickly diffused and requiring workers to adjust and reconfigure the workplace. Processes like electrification, railway transportation and communications are considered examples of GPT (Crafts [2004]).

Most of the efficiency gains from transportation developments were related to a learning process and organizational changes rather than technological changes, and these also required an effort from the labor force. Shepherd and Walton [1976] show that in-port time was dramatically reduced thanks to organizational improvements that allowed ships to spend less time loading and waiting thus leading to reduced shipping costs as a result of knowledge and skills acquisition by crew members. On the contrary, navigational technology development was a long-term process where high incentives were key to the development of new technologies. According to North and Thomas [1989], it took more than two centuries for navigators to find an instrument to calculate their precise position.

Advances in land transportation were even slower. The shift from horse transportation to the railroad started in the north of England in 1826. However, the evolution of land transportation was crucial for the integration of the American economy. By the Great War, the USA had laid a million kilometers of railroad tracks, representing half of the worldwide service. The network allowed the increase of the geographical extension of the country and reduced the distance between urban centers. Mechanical refrigeration cars introduced in the 1870s enabled long-distance transport of fresh meat and dairy products by rail and sea, and improved the nutrition of many clusters of the population in the West. Maddison [2001] explains that regular transatlantic shipping lines were not established until the 1880s, when goods and persons could be moved from Liverpool to New York in only 10 days. During the colonial period maritime transportation was the second biggest sector (10 per cent of the labor force) in the US. The remarkable yearly 0.8 per cent average productivity growth in the shipping industry was important to the overall economy. Transportation developments implied not only the movement of high volumes of products in shorter time, but also the increased efficiency of organization that led to wholesale storage cost reductions. Companies were much bigger and de-localized; this required greater organization between companies, branches, divisions and local governments that took some time to implement efficiently.

In the last three decades, the transport industry was prone to liberalization, which fostered changes in the structure, performance, and quality of aviation, trucking, railroads and ocean shipping industries. According to the Bureau of Transportation Statistics (2000) recent growth has provided unprecedented levels of mobility and contributed to the enormous economic prosperity of the last decade. Since 1975, passenger-miles of travel doubled, while transportation fatalities and environmental impact have sharply declined.

The role of private transportation is even more important in terms of mobility. In 1908, Henry Ford was determined to build a 'car for the great multitude'. The car was sold at $825 , but its price dropped to $572 by 1912 (average GDP was around $1,800 per capita), and could be paid in different instalments. By 1927, the Ford Motor Company had sold 15 million Model-T cars. Other great companies like Chrysler and General Electric were also flooding the market and increasing living standards for the median consumer. The diffusion of the auto-mobile reduced rural isolation and brought urban amenities and infrastructure to rural areas; it changed the composition of cities and neighborhoods and promoted the proliferation of residential suburbs, allowing commuting between nearby towns. Consequently, tourism-related industries, entertainment, lodging, accommodation and public provision of highways and paved streets increased from the 1950s.

As a consequence of the diffusion of the railroad network, the introduction of the telegraph enabled long-distance instantaneous communication. By 1913 its role had been reinforced by the introduction of the telephone and the radio. By 1960, 80 per cent of American households had installed a private line and the gap was concentrated in southern states (Mississippi, Arkansas or South Carolina) where only half of households had access to a line. By the year 2000, only two per cent of total households did not have an available unit installed. In the 1990s telephone communication became instant, wireless and cheaper. According to the Statistical Abstract of the United States (2009), the number of regular telephone line units grew by 88 per cent from the 1990 to the 2000s. The behavior of wireless communications was even more astonishing: line subscribers grew at an outstanding 1,972 per cent in the same decade (from 5 to 110 million users).

Advances in transportation and communications did not only impact the movement of goods and services but also enabled the geographical transfer of mobile factors (capital and labor). Cheaper passenger costs and time reductions of communications changed migratory movements. European migrants were usually employed as unskilled labor in agriculture. The most dynamic industries (manufacturing, mining and managerial activities) were demanding high amounts of skilled labor. This pattern led to a reduction in the salaries of the poorer domestic workers, increasing the income gap between rural and urban areas.

O'Rourke and Williamson [2001] suggest that there was a regional trend too. Migrants originally moved to expanding markets (big cities in North-Eastern states). They suggest that migrant workers were cheap substitutes for domestic labor. Thus, the massive affluence of migrants to big cities had a negative impact on the urban salaries of the East coast. Overall, international migrations reduced salaries by 15 per cent pushing domestic workers to move into less congested areas in the West coast, further expanding the growth of the region.

In sum, internal factor movements were fostered by lower costs of transportation and communication and had an impact on previously lower populated towns in the West coast. Factor movements reduced the urban gap and inequality between the East and the West. The structural change from agriculture to industrial production arose in these states too, however, the shift was not proportionally allocated. The next section shows that the development of urban areas during the 20th century was linked to the growth of the service economy, and in particular to the knowledge intensive sectors, increasing the persistence of regional and individual inequalities in the long run.

2.4 The service industry

As mentioned above, the role of the manufacturing sector was central to the evolution of the country from the 1840s. However, the growth of the service economy was not sudden, but it rather grew steadily with income per capita as well.

> *'Despite all the media attention given to de-industrialization and the emergence of a service economy in recent years, history reveals that the service sector, in fact, has also grown fairly steadily following two notable declines, the first immediately following the Revolution, the second following President Jefferson's embargo of foreign trade in 1807. In particular, retail trades, financial services, and the like grew specially rapidly with spreading urbanization especially from 1910s.'*

In fact, Atack and Passell [1994] regard the growth of the service economy as a necessary condition for urbanization. In the 1700s, merchants were the main service occupations, but it was already the second biggest sector in the American economy. Trade, utilities and communications are generally correlated to the size of the market, as they support the functioning of the economy by reducing transaction costs. In general, highly populated areas have a bigger share of workers devoted to finance and commerce.

On the other hand, the clustering of the innovation sector is randomly distributed across different cities in the North-East and the West, whereas traditional manufacturing industries tend to be tied to the location of natural resources. Thus, oil industry clusters are necessarily located close to large oil reserves (Texas, Alaska and Louisiana) and wine producers locate where the climate is propitious (California). On the contrary, the service economy is everywhere, supporting oil, wine, and knowledge intensive sectors.

According to the Statistical Abstract of the United States (2009), California and New York account for 21 per cent of total GDP, devoting most of their product to Financial and Real Estate Services and Professional and Business Services. These sectors together represent 28 per cent of total US GDP, implying that most of these services are produced by these states. Krugman's index measurement of relative specialization shows that, on average, counties became more diversified until 1980 but more specialized by the 2000s using different classifications (ranging from 3 to 10 industries).

The key to the recent regional specialization comes from the patterns of growth across sectors. Traditional manufacturing and agriculture have shrunk, but sectors based on information and technology have been increasing steadily over the century. Moretti [2012] estimates that the number of jobs in the Internet sector reached around three million. The sector grew more than 634 per cent from 2003 to 2013 (not including Internet-related jobs outside the high-tech sector, like the delivery of on-line purchases). Although these technologies benefit the growth of most sectors, these seem to be produced in innovation clusters located in big cities across the North-east and the West. The reason for this random clustering close to crowded cities such as New York, Chicago, Los Angeles, and San Francisco seems to be related to the size of population. In other words, big cities are specializing in knowledge intensive service sectors, becoming larger and attracting skilled and unskilled workers from smaller cities. As a result, workers from small cities are abandoning their home-towns in fear of becoming part of the rural US. County inequality is increasing, although big metropolitan areas in the upper tail of the distribution are becoming more equal among themselves (Desmet and Fafchamps [2004]).

When the economy specialized in manufacturing, it did so at the expense of agriculture rather than services. In fact, the service economy continued its stable path of growth with the development of managerial and distribution activities. An obvious impact of these new technologies on the service economy is the 'distribution revolution'. By the 1850s, wholesale traders were substituted by malls, like Macy's, that offered greater varieties of goods. The retail distribution of clothing, and home-ware utensils began in the biggest urban areas like Boston and New York in the 1860s and in Chicago, Washington and San Francisco later. The role of postal shipping was also important for the distribution of goods and grew at the beginning of the century before markets grew in larger towns and the auto-mobile was spread across the population. Nevertheless, the transportation and communications revolutions proved fundamental for the rest of the industries, needed for the development of mass production as explained by Rostow [1956]. The Internet and the aircraft have expanded markets and decreased distance even further. In the last few decades, however, the demand for individualized products has increased in particular segments of the market.

Thus, manufacturing companies grew substantially and became geographically dispersed, increasing coordination and information networks even at a multinational level. The large amount of data drove the increased presence of white-collar jobs and women's entry into the labor market (in 1930 around a half of white-collar jobs were occupied by women, according to the US Census records). With the development of professional occupations, companies became more centered on the research and design of new products, while manufacturing activities were increasingly outsourced to other countries. This was part of the shift from manufacturing to the service economy and had unequal consequences across regions: while Silicon Valley became more prosperous, Detroit started a rapid decline phase.

Furthermore, a sizeable share of the tertiary sector comes from personal services, increasing with income per capita, which was the case at the time. From 1950s however, the role of the service economy becomes much more relevant thanks to the start of the modern office and the development of non-market business services (Broadberry and Ghosal [2002]). The development of manufacturing led to unprecedented growth in the US that accelerated the development of the financial system.

According to Maddison's data, by 1913 the United States operated closest to the technological frontier. Between 1913 and 1950 TFP grew by 1.6 per cent a year, more than four times as fast as the TPF achieved by Britain from 1870 to 1913. The second half of the century has accelerated the divergence between the US and Europe. This was partly an effect of several conflicts that destroyed European infrastructures and the relative inland peace of the USA, and partly because US workers remained more productive. During the first half of the century, TFP growth was unpredictable, uneven and related to general purpose technology (electrification). Bakker et al. [2015] show that TFP accounted for 28 per cent of growth whereas labor quality had a much higher contribution than expected. The productivity of entertainment industries grew at similar levels than the most dynamic manufacturing sectors and represented a big share of Value Added in the first half of the century.

Communications increased the size of these markets as well as any industry where information was a key input. Thus, the financial sector became very dynamic, increasingly skilled and worthy of a fourth of the Gross Value Added of the US economy in 1976 (the same as manufacturing) and almost 40 per cent in 2009 (Timmer et al. [2014b]).

Financial services have increased as a result of both the increase of economic activity and the development of general purpose technologies like computers. According to David and Wright [2003], the extent of 'computerization' for the service economy in the 1980s was roughly comparable to the degree of electrification of manufacturing at the beginning of the century. By the 1980s, technological advance was much more common in sectors operated by very skilled employees, leading to the skill-biased development of technology, Goldin and Katz [2009]. This way, a society with a highly skilled labor force had better chances of maintaining its leading position.

2.5 Conclusion

This brief review of the 500 years of American economic history has shown that the central element behind the supremacy of the US over the last century has been human capital. Comparative advantage in natural resources may have helped at the initial stages of development, although most of the productivity enhancements have occurred thanks to a big homogeneous market and a skilled labor force.

This chapter has assessed the role of manufacturing as a crucial episode in the economic history of the United States. However, key to its transition from the agrarian stage to its world supremacy has been the huge effort to foster innovation. Regardless of a contemporaneous decline in the rate of school completion, schooling differentials have accelerated the income gaps between professionals, between industries and consequently, between regions. Despite living in one of the quintessential clusters of knowledge services in the world during the 1950s, Rostow, a famous economic historian whose ideas were clearly capitalist, could not yet envision the impact of the service economy. When he developed his famous non-communist manifesto describing the stages of economic growth, he postulated that ‘the United States of the 1840s and 1850s had been preparing for industrialization since the 1790s, at the latest’. In this light the history of the United States should be re-told as a story of knowledge and skills. Perhaps, the view of the United States as an industrial country should be re-written as that of an economy that had been preparing itself to be the leader of knowledge services since 1880 at the latest.

Part II

CHAPTER 3

From farmers to designers: long-run evolution and localization of services. USA, 1930-2010

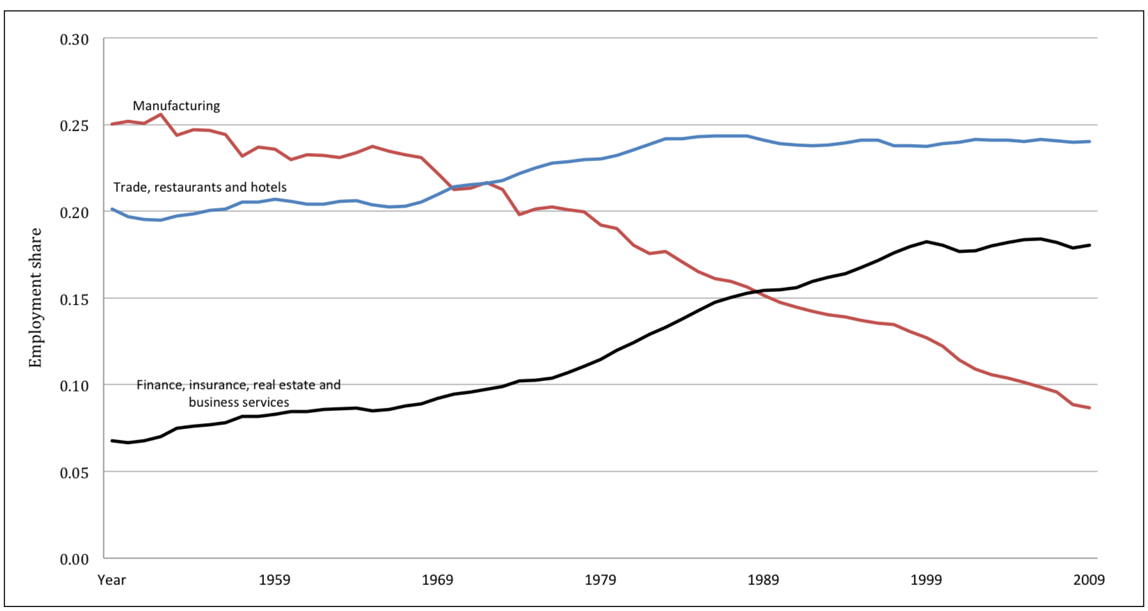
Economic historians have extensively studied the contrast between manufacturing and agriculture to explain development gaps. However, the increasing role of the service sector has only been marginally explored. This chapter provides evidence on the service economy using a brand-new series of concentration. In accordance with the scarce available evidence, this chapter shows that 20th century service employees have been more proportionally allocated than non-service employees. However, during the last few decades knowledge intensive sectors have been agglomerating more than proportionally in big urban areas and have even managed to overcome some manufacturing industries thanks to technological advance. These conclusions suggest that knowledge services might induce contemporary development differentials.

JEL classification: L8, N72, R12, O18.
Keywords: New Economic Geography, Agglomeration, Service Location, U.S. Counties.

3.1 Introduction

Until very recently, economic historians have tended to use the contrast between manufacturing and agriculture to explain development gaps, thus ignoring the service economy. The proportional distribution of traditional services justified overlooking this part of the economy leading to potential imperfections in economic theory. Recent technological changes have increased the share (Figure 3.1) and value (Figure 3.2) of skilled service employment in most developed regions, triggering a growing interest in the service economy. Using a new dataset this chapter shows that overlooking the service economy leads to erroneous theoretical oversimplifications with respect to localization. Services have been increasingly agglomerating in urban areas, driven mainly by highly skilled employment. In contrast with the traditional understanding, the allocation of service employees is not related to population; results show that the distribution of knowledge intensive services is highly disproportional and has even managed to overcome some traditionally localized manufacturing industries. The disaggregated analysis of narrow geographical scales such as counties instead of states or countries generates substantial information that changes the conclusions of traditional economic models.

Figure 3.1: Employment shares by sectors

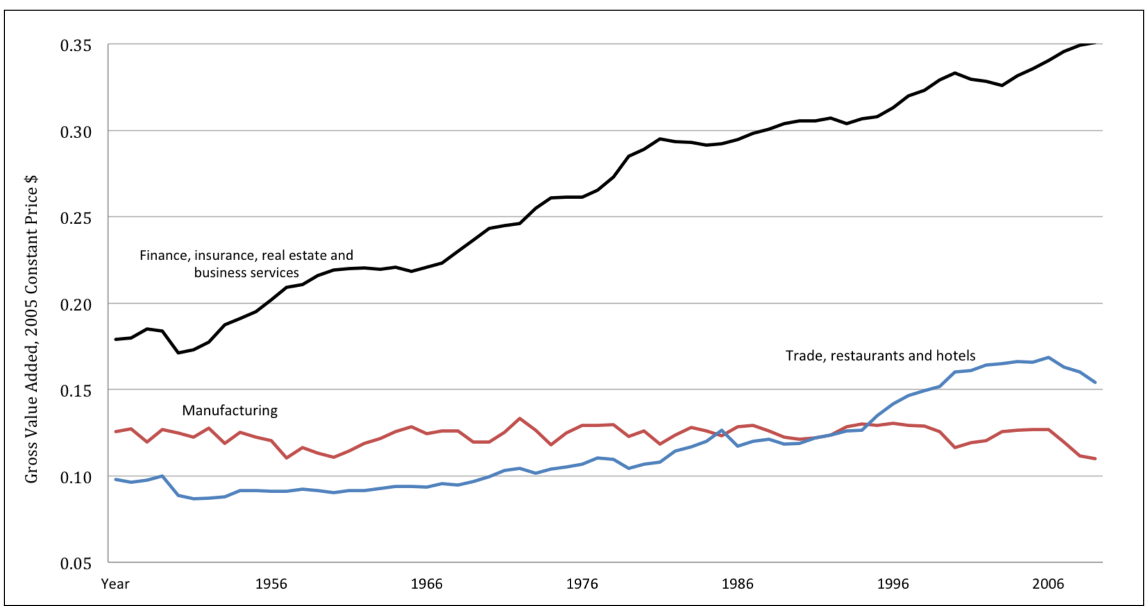


Source: Timmer et al. [2014a].

This chapter presents a new long-term series of concentration patterns by sector across the 20th century using county employment data of the United States. This new series describes the localization trends of employment by placing emphasis on the service sector. With this purpose, I propose an examination of three dimensions that affect the agglomeration of employees and economic activity: path dependency, geographical conditions and industrial linkages.

Initially, path dependency describes the mechanism by which counties with a relatively high initial proportion of knowledge intensive workers attract more skilled employment. Geographical conditions might affect both demand and supply of employment. Regarding supply, factor price differentials foster mobile factors like labor and capital to move where returns are higher (hence, attracting more workers to urban areas). Second, the Economic Geography argument postulates that firms allocate close to demand, with big urban areas providing bigger markets and attracting new firms. Lastly, industrial linkages might promote lower production and transaction costs both to providers and potential customers. These three dimensions help explain the patterns of localization of new high value firms in cities that seem to be fostered by the initial endowment of a knowledge economy.

Figure 3.2: Contribution to Gross Value Added by sectors



Source: Timmer et al. [2014a].

My results confirm that manufacturing and agriculture tend to allocate more disproportionately than the service economy and that this disproportion tends to occur in large regions endowed with good natural conditions. The service industry, on the other hand, seems to be more dispersed and its mild disproportions are only perceptible at smaller scales (counties). However, the service sector has become more concentrated in the long run. According to these results, the service economy is more path-dependent than spatially correlated to the neighbors, at least at the county level. However, industrial linkages also seem to determine an important part of the cross-sectional differences. On the one hand, traditional services provided directly to the final consumer (Personal Services, Utilities and Trade) are generally distributed in proportion to population; however, Knowledge Intensive Services (usually supplied to businesses) concentrated in particular regions through the century and drove the overall service sector (and the aggregate economy) to localize in cities more than proportionally through a multiplier effect.[1]

The chapter is structured as follows, after this introduction, I explore the trends of sectorial allocation using an inequality indicator analogous to the Gini Index defined by Krugman [1991]. Then, I identify where the disproportion occurs and show how certain counties affect the employment distribution of their neighbors through spatial correlation, and how specialization in agriculture prevents or hampers the entry of alternative sectors. I finally summarize the main conclusions of this descriptive analysis.

3.2 Literature review

Although the benefits of specialization were already highlighted by classical economists in the late 18^{th} century, data on the location of firms were not even gathered until 1860 when the US Census Bureau published statistics of workers per industry and state. The next available document on this issue is a monograph

[1] Also known as *Knowledge Intensive Business Services (KIBS)*, as Ciarli et al. [2012] denote them. In this investigation, these are simply referred as Knowledge Intensive Services because their main characteristic is the relatively high human capital and information input instead of the kind of consumer.

on industry shares in the US published in 1900.[2] More recently, a number of papers have analyzed the trends of concentration and specialization during the last century and conclude that, overall, the 19$^{\text{th}}$ century was a period of greater specialization and concentration while the 20$^{\text{th}}$ century fostered de-specialization. These studies identify transport and information cost reductions as the main drivers of the trends.

Among others, Kim [1995] and Krugman [2009] demonstrate that non-service sectors have traditionally been more concentrated. However, they explain that both service and non-service employees have become increasingly agglomerated over time. In the same line, Desmet and Fafchamps [2004, 2006] observe that these traditional patterns hold during the period 1972-2000, when total employment has become more unequally distributed. They suggest that, in the last few decades, non-service employees have spread out while service employment has become more concentrated in urban areas, creating a divergence in the distribution of employment across counties. Overall, recent research argues that services are driving the dynamics of aggregate employment in the United States.

Those that defend the role of factor endowments rely on neoclassical trade theory. More specifically, the Heckscher-Ohlin (H-O) framework deals with factor prices based on initial endowments: space is heterogeneous and creates production cost differentials. The introduction of relative measures based on opportunity costs implies efficiency gains if nations produce and trade only what they can produce at a lower relative opportunity cost (David [1817]). This premise implies that even with no absolute advantage, any region can benefit from specialization in a good that has a lower opportunity cost. Regions with access to natural endowments will tend to specialize in the primary sector. With high transport costs, these regions will also attract manufacturers whose production is intensive in these raw materials. Production that is intensive in the use of mobile factors (labor and capital) will move elsewhere (intuitively, where there is a labor advantage). Kim [1995] defends the role of comparative advantage but accepts that it is not the only explanation. He finds that resource allocation explains the cross-sectional variation in localization but accepts that time variations can be explained by the size of demand.

[2]There were several previous census-like publications of manufactures and workers (1810). These were mere enumerations and only the ones published from 1850 would be used for later long-term statistics.

Accordingly, more recent research points to increasing returns and market size as the key behind allocation. When producing at Increasing Returns to Scale (IRS), any increase in inputs leads to a more than proportional rise of output. IRS can be originated from external economies of scale, through synergies from the interaction with other agents.[3] Particularly, the so-called *Principles of Economics* formulated by Marshall [1898] explained that industries benefit from locating close to peers, providers and big labor markets - that is, close to big urban areas.[4]

A complementary view was probably inspired by the ageing of the mass production model during the 1960. Jacobs [1970] argued that the key to external economies was industrial diversification rather than specialization. In this sense, a diverse society tends to grow further by applying the success formulas 'between rather than within industries' (Glaeser et al. [1991]). In sum, Jacobian externalities suggest urban clustering promotes growth through diverse knowledge spillovers. This reasoning fosters industries not to cluster among peers but to distribute close to distinct industries. In a multilevel analysis the key is how to define what different industries are: the question is at which interaction level of the Industrial Classification are external economies created.[5]

In any case, both views imply that being close to large sources of local demand, peers (diverse or similar) and pools of labor- that is, being close to the market- provide lower costs of production and thus higher profits for firms based on external effects. However, being close to the market also involves higher competition that may lead to the reduction of the effects of agglomeration economies: disper-

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[3]IRS can also be internal to the firm. This occurs when fixed costs are big relative to variable costs. Firms that operate at IRS have a decreasing unit cost. Therefore, the greater the market access, the higher the profit. Utilities and knowledge intensive services are generally examples of high fixed and low variable costs. In this context it is crucial to understand the trade-off between transport costs and IRS: if fixed costs were zero, firms would allocate in proportion to the market size to reduce delivery costs; if transport costs were zero a sole plant could manage to supply the entire market. In the real world, a plant provides consumers within a certain radius that depends on transport costs and the intensity of IRS. The debate of IRS from internal economies is also present in this investigation, because it considers the geographical allocation of workers ignoring whether they work in different competing firms or in a monopoly situation.

[4]External economies tend to be summarized as 1) a greater pool of skilled labor and, thus, lower labor costs, 2) the possibility to favor from spillover effects as information flows easily in crowded areas and 3) decreasing costs from providers thanks to competition in large markets.

[5]ISIC (International Standard Industrial Classification) and NAICS (North American Industry Classification System) classify industries at several levels (Sections, Divisions, and Groups). The level at which Jacobian externalities operate is crucial. For instance: Section: M - Professional, scientific and technical activities > Division: 72 - Scientific research and development > Group: 721 - Research and experimental development on natural sciences and engineering

sion economies or agglomeration dis-economies. Desmet and Fafchamps [2004] support the Jacobian hypothesis by arguing that the upper-tail of employment distribution has converged (i.e. cities are becoming more equal) but the whole distribution across counties has become more unequal, diffusing most of the service economy to nearby cities and creating an urban-rural dichotomy.

Krugman [1991, 2009] summarized the framework of the New Economic Geography (NEG) theory, which by allowing Increasing Returns to Scale into the monopolistic competition model, reveals that industry localizes according to the size of the market. However, several papers -including Helpman and Krugman [1985] - argued that this theory can co-exist with traditional economic thought. In fact, even those who dismiss the criticisms made by NEG test their theory against both possibilities finding some evidence for the mixed model.

One of the main contributions to the literature on the localization of industry in the United States is Crafts and Klein [2012] who show that economic geography was more relevant than factor endowments to the existence of the manufacturing belt. Natural advantages played a role in industrial location decisions during the previous century but technological advance lessened the importance of natural advantages over time.

In general, results are influenced either by the choice of industries (which is either too broad or entirely focused on manufacturing), or by the unit of analysis (usually too big: states, regions or cities) leading to biased results. Ellison and Glaeser [1999] observe that the importance of resources is usually underestimated. Together with Dumais et al. [2002], they find that natural advantage explains about 20 per cent of the concentration of industry. However, their results prove that access to a big market is more important than the presence of supplies when the study is performed by county, leading one to question the choice of geographical scales of analysis (cities, counties or regions).

Ellison and Glaeser [1999] also observe that employment concentration measures do not take into account the correlation of number of plants with employment concentration. That is, by using these measures one might mistakenly conclude that agglomeration economies motivate firms to concentrate when it could actually be about a monopoly situation. Acknowledging the difficulty of finding these kinds of data for long term analysis, Maurel and Sedillot [1999] use a probability model to measure the probability that firms locate away from the random distribution. Furthermore, Duranton and Overman [2005] discard the discrete geographical classification in which scholars in general do not agree upon, and base their research on a continuous actual distance between plants approach. Applying this to a long-term analysis is hard given the thoroughness of the data requirement.

Taking into account this available evidence and its shortcomings, this investigation takes into account possible biases that scholars may have suffered exploring manufacturing through the methods explained in the next section. Using a disaggregated geographical scale over the complete geographical distribution across all the sectors in the economy aggregated at an adequate industrial level provides a proper description of the patterns of localization of the service economy.

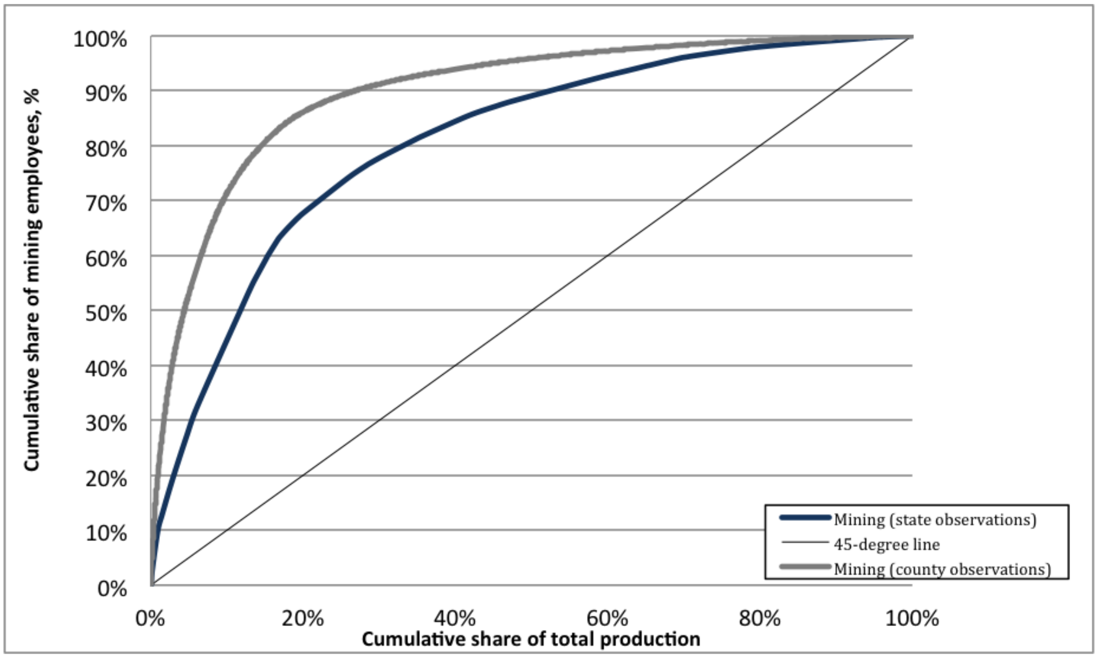
3.3 Empirical framework

3.3.1 Methodology

Relying on the previous literature, this research is based on the analysis and construction of employment distribution shares and concentration indicators based on industry and county employment data for five benchmark years. In particular, I use Locational Gini coefficients on employment data by sectors following Krugman [1991] as an indicator of geographical inequality by industry to show the geographically disproportional allocation of employees.

Locational Gini coefficients are analogous to traditional Gini coefficients of inequality: its value ranges from zero (showing a perfectly spread distribution) to one (showing perfect disproportion). These inequality measures are both derived as the area between the perfect proportion line and the (Locational) Lorenz Curve. The Locational Coefficient version differs from the conventional Gini by taking into account that individuals (in this case, counties) differ in population size. Thus, Locational Gini Coefficients analyze the mismatch between the employment allocations with the national share of that industry in total employment, measuring the difference of the allocation with national proportions.

Figure 3.3: Mining Lorenz curve, 1980

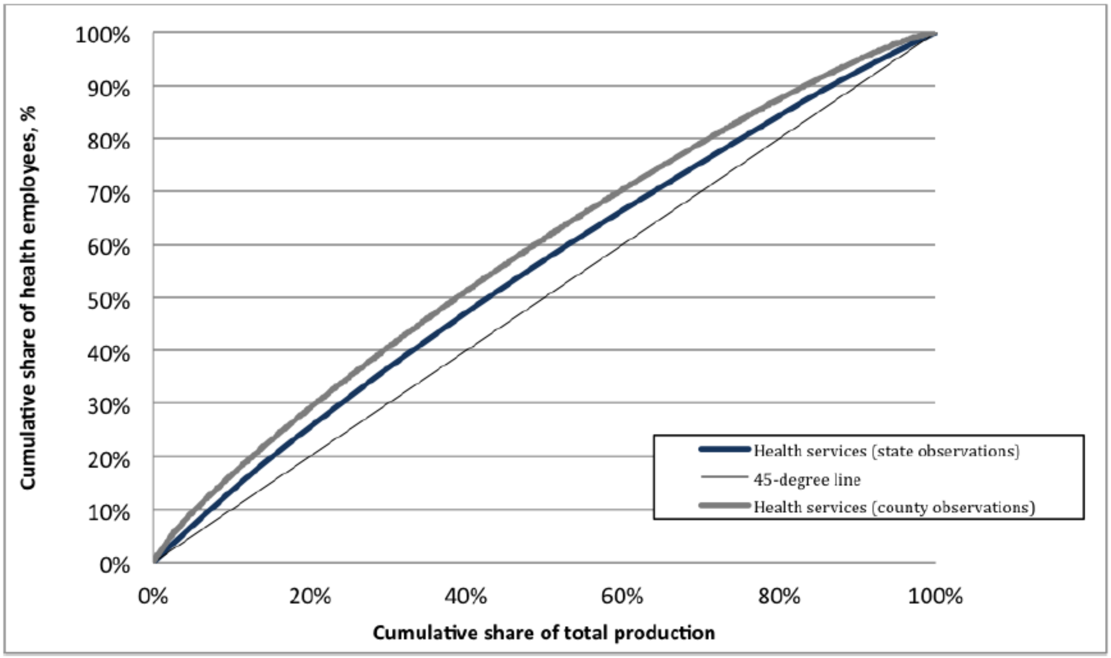


Source: own calculations from US Census data.

Take Figures 3.3 and 3.4 that show the curves for 1980 data on Mining and Health Services industries respectively as illustrations of a localized and a spread sector respectively. The areas between the Locational Lorenz Curves and the 45-degree straight lines represent the Locational Gini coefficients. As shown by these Figures, the Locational Gini coefficient for Mining employees is bigger than the coefficient for Health Service employees, in accordance with the traditional argument that services tend to spread in proportion to population size. These results are persistent in all benchmark years as confirmed by the decomposition of General Entropy indexes of state employment shown in Figure 11 in the appendix.

Note as well that both sectors show more localized employee distributions for counties than for state observations. This finding reveals that broad scales bias part of the localization effect of industries, where the size of the fault for spread sectors is relatively bigger than for concentrated industries, leading to misleading conclusions in the case of traditionally spread sectors such as the service economy and utilities.

Figure 3.4: Health Lorenz curve, 1980



Source: own calculations from US Census data.

Information on concentration only shows one side of the coin: how geographically disproportional is the allocation of employment by industry. The same data, if properly arranged, allows the measurement of a complementary piece of information: regional specialization, which shows how disproportionally devoted to an industry is the labor force in a county.[6] A simple way to present this two-dimensional information is by using Hoover's index of concentration, which measures the intensity of disproportion of workers in an industry per area and is comparable across the whole country and industrial classification. Formally:

$$L_{ir} = \frac{(E_{ir}/E_i)}{(E_r/E)} \tag{3.1}$$

Where, E_{ir} is total employment in industry i for region r; E_i is total employment for industry i for the total of the country; E_r is the total of employment in region r; and E the total employed in the country.

[6]For more details, see Aiginger and Davies [2004].

This index measures whether the proportion of workers of an industry in a region is proportional to the participation of that area in the overall production of the country. This indicator is lower bounded at zero; a value of one indicates perfect proportion whereas a lower value suggests a less than proportional allocation, and a greater value signals a higher disproportion. It serves as an indicator of the labor advantage participating in an industry in each county in comparison to national shares. Thus, it provides an observation per county instead of a summary value for the whole region. Maps are a useful tool to present the information provided by these Location coefficients effectively and help identifying whether there is a geographical pattern of areas attracting a greater than proportional amount of an industry.

Subsequent sections of the chapter rely on these observations to analyze the long-run geographical distribution of employees by sector. These will show the evolution of the economy, labor force and regional development patterns over the period 1890-2010.

3.4 Data

3.4.1 Data collection

The longitudinal panel data set consists of more than 12 thousand observations of employment data by industry. Observations have been taken for five benchmark years (1890, 1930, 1950, 1980 and 2010) in order to capture the effect of the milestones of the history of the United States of America on employment patterns but still allowing a manageable set of data. The sample includes all the counties in 50 states (a total of 3,189) and 15 industries.[7]

[7] In several occasions Hawaii and Alaska data are missing. The maps used to represent results will not represent these two states in order to provide a more comfortable visual idea. However, the data will be used when possible for calculations.

The main sources for the data are derived from different publications of the US Census Bureau: Housing and Population Censuses (11^{th}, 15^{th}, 17^{th} and 20^{th}), County Business Patterns (2010) which provides sub-national data classified by industry (number of establishments, employment, payroll...) and Agricultural Censuses from 1980 and Craig and Weiss [1998] estimations from the year 1890. Given the heterogeneity of these sources, building this dataset has implied an important work of homogenization to allow for a comparison across industries.[8]

The US Census Bureau's reports are very rich in the quality of geographical data. They provide several aggregations: by census regions and divisions, political units (states, districts, congressional districts, counties...), rural-urban classifications and several statistical methods. A key criticism of the current literature is that most authors use unsuitable geographical units. Krugman [1991], Kim [1995] and Crafts and Klein [2012], among others, have studied industry agglomeration of employees by state. Later, Kim and Margo [2004] presented results by region and others chose countries as a geographical unit (Davis and Weinstein [2003]). Using these units, Crafts and Klein [2012] and Krugman found evidence of external economies determining localization, due mainly to the detailed nature of their industrial scope. A possible explanation of Kim's findings is that the choice of broad geographical scales ignores the subtle effect of external economies that occur at a local level.

Alternatively, some scholars propose using smaller geographical units like cities or urban areas; however this choice leads to the use of scattered non-randomly selected data that ignores equally important information: de-localization. The study of urban areas performed by Ellison and Glaeser [1999] or cities by Glaeser et al. [1991] neglects the effects of availability of natural resources in rural areas and ignores the lower tail of the distribution of certain sectors -including agricultural producers-, obtaining biased results. Moreover, the discrete use of areas instead of a random selection covering the whole country permits a proper study of regional specialization but a very poor analysis of industrial concentration; this leads to

[8] Check the Appendix for more information on the data collection process.

poor results in the analysis of industrial disproportion. Similarly, the choice of SCSA or SMSA would leave small cities and rural areas out of the model as well and is thus unconsidered although the comparison of SMSAs and the localization of certain industries might be interesting to find an urban pattern.[9][10]

In Marshall's words:[11]

> "*Economies of massive production are of many different kinds: some are cosmopolitan property, some are national, some are local, and some belong to individual firms: each of these different kinds has its own method of affecting both the national and social issues in question.*"

Acknowledging this possible bias, some authors like Ellison and Glaeser [1999] found that results differ when the geographic unit is changed; this finding motivated the development of a model to explain differences in productivity at two geographical levels. More specifically, Ciccone and Hall [1996] explain that productivity differences across states are explained by employment patterns by county. They argue that capital is important for the state differential but that IRS are key for local gaps. For them, agglomeration can be decomposed into national, state and county effects. Kim and Margo [2003] admit that the patterns that hold at a regional level may not hold for smaller local areas. Therefore, analyzing agglomeration taking into account the different geographical perspectives makes for a more complete outline of industry concentration.

Under the premise that external economies could be overlooked if the unit of analysis is too broad, the main geographical unit used in this investigation is the county. However state boundaries and standard Statistical Metropolitan Areas (SMA) are also considered for comparative purposes.[12] This preference creates a

[9]The same problem occurs in scholarly articles where the units of analysis are cities, like Kim [1998, 1999] Nelson [1955] and Glaeser et al. [1991], Ellison and Glaeser [1999] who even try to perform an analysis by collecting data at firm level instead.

[10]SMSA (Standard Metropolitan Statistical Areas) comprise one or more counties around a central urban area of more than 50 thousand inhabitants and a total of at least 100 thousand inhabitants. Standard Consolidated Statistical Areas (SCSA), which are composed of two or more close SMSA with a combined population of one million.

[11]Alfred Marshall (1919), Industry and Trade, pp.96.

[12]Note that using county data permits obtaining the classification by state at almost no cost. These data are presented as well with the purpose of comparison.

sample size increase from 52 (states) to 3,139 (counties) observations per industrial group. Although more observations offer greater accuracy, they come at the cost of a lower manageability of the dataset. As previously explained, the employment data used in this project have both a geographical and industrial dimensions.

The ultimate sample would contain the most detailed level of both industrial classification and geographical layers. Nevertheless, NAICS classifies industries with a disaggregation up to six levels.[13]

Table 3.1: Industrial classification by sector

Primary Sector
Agriculture
Forestry and fisheries
Mining and Quarrying
Secondary Sector
Construction
Manufacturing
Tertiary Sector
Utilities
Transportation and Warehousing
Telecommunications
Utilities and sanitary services
Trade
Wholesale trade
Retail trade
Personal Services
Repair services
Private households
Hotels and lodging places
Entertainment and recreation services
Health Services
Education
Other Personal Services
Organizations
Finance, insurance and Real Estate
Knowledge Intensive Business Services
Business services
Professional Services: legal, engineering & other
Public Administration

Source: edited by the author based on the North American Industrial Classification System.

[13]The ISIC system was developed by the United Nations and used internationally. It has experienced several revisions consistent with the changes of production in several countries (Revision 1 in 1958; Revision 2 in 1968, Revision 3 in 1989, Revision 3.1 in 2002 and Revision 4 in 2007). In 1997, Mexico, Canada and the United States developed their own comparable system to better capture the process of production in America.

A database of records at three-level codes would consist of 161 industry groups for each county, resulting in around 500,000 observations per benchmark year. More than this, as production itself has changed through time, the NAICS system has been modified on several occasions, hindering the homogenization of long-term data and requiring the use of a more aggregated classification. The final longitudinal panel database comprises an industrial classification homogenized to fit all the observations in each benchmark year provided by the US Census (see Table 3.1). Depending on the year, it contains a maximum of 28 categories of which 21 belong to the tertiary sector.

The trade-off between industrial detail and geographical accuracy has been resolved in favor of geography based on the argument of the potential biases caused by broad or incomplete geographical units. The choice forces less accuracy in industrial detail but the database offers a more decent visibility of the service sector than any available records.

3.4.2 The distribution of employment

One of the key elements to address regarding the importance of services is the transfer of employees across sectors through time. This text has already emphasized that the value and extent of service production has increased through the century (Broadberry and Ghosal [2002]; Moretti [2012]). Accordingly, the share and number of employees devoted to the tertiary sector has increased substantially. Table 3.2 shows labor force participants by sector both in absolute terms and as a percentage of total participation from 1930 to 2010. The first remark is that the total number of employees has increased from 24 to 122 millions since 1890, excluding the period after the Great Depression. The number of employees devoted to services is now the biggest share of the economy (it has increased from 31 to 82 per cent in a century). Meanwhile, the primary sector has shrunk by 44 per cent during the whole period, although the Great Depression had a greater impact on the agricultural sector in detriment to manufacturing.[14] Recovery during the Golden Age increased the share of manufacturing until the 1970s when the sector began to decline and employment moved gradually to the service economy.

[14]Similar figures are shown in Lebergott [1966].

This change in total labor force composition has been paired with a change in the distribution of sectors across the US geography, which has become more unequal. Table 3.4 shows variances and inequality measures for all the sectors in 1980. These indicators are not adjusted to proportion and, thus, can be biased with the population size of the county. However, these still provide a good initial understanding of sectoral differences by showing where extreme allocations and inequalities occur: if inequality is high, there is a high variance among the distribution of employees in each industry per county (a greater range of values). On the contrary, low inequality shows that population size is not very relevant to the allocation of that sector, and it may indicate that resources may be more essential to that industry. In other words, high inequality measures show industries that tend to allocate in big urban areas, as explained by Desmet and Fafchamps [2004].

1980 data show that the greatest dispersion occurs in manufacturing industries (Textiles, Machinery, Chemical and Metal Industries) where IRS (from internal economies of scale) have traditionally been identified. However, these are closely followed by certain services (Insurance, Business Services, Other Education, Entertainment and Professional Services). In the case of services, inequality seems particularly significant in the upper tale of the distribution, in other words, highly populated counties are the key to these industries.

Table 3.2: Labor force participation by sector

	Total Employees (millions)	**Primary Sector**	%	**Secondary Sector**	%	**Tertiary Sector**	%
1890	24	11	44.11	6	24.88	7	31.00
1910	36	12	34.49	10	27.17	14	38.34
1920	40	11	28.50	12	29.80	17	41.70
1930	48	12	25.00	14	29.17	22	45.83
1940	48	10	20.12	14	30.21	24	48.15
1950	57	8	13.94	19	32.49	30	53.11
1960	64	5	7.64	21	33.16	38	55.28
1970	76	4	4.52	24	31.84	49	63.63
1980	97	4	4.03	28	28.30	66	67.67
1990	115	4	3.31	28	23.89	84	72.81
2000	122	5	4.10	17	13.93	100	81.97

Data shown in million employees and as a share of labor force. *Source: Carter et al. [2006], American Community Survey for 2000 data and US Census Bureau 15th Decennial Census for 1930 data.*

The last two columns of Table 3.4 show a differentiation concerning between-state and within-state inequality. In the case of 1980, the decomposition reveals that county differences are more relevant to the disparity than between-state inequalities. The exception is the primary sector, where natural advantage is particularly necessary (state-effect seems to contribute to about 30 per cent). In general, the lowest dispersion in allocation is shown in sectors like Forestry and Fishing and Agriculture, which means that the local size of the population is not very relevant and instead, available resources are crucial. For the rest of the sectors, between-state inequalities are negligible in comparison with within-state variance, which leads to further proof of the need to analyze the distribution using narrower units than states. These results are in accordance with the state-county decomposition effect of the General Entropy index shown in the appendix (Figure 11). Although the data not shown here, this outcome became more pronounced for more recent data (2010).

In sum, the importance of agriculture was crucial during the crisis but manufacturing jobs took over the growth of the US economy until the 1980s. The service economy has gradually become the motor of economic growth across the whole period. The crucial question is whether the growth of the economy, measured in this case by the total number of employees, has anything to do with the size of the service sector. Table 3.2 shows that these raw indicators move together: an increase in the share of services is related to an increase of the total number of employees. But, is this effect generalized across the whole country? Note that not all the counties behaved the same way over the period. The American population increased, but the effect of migratory movements led counties to grow unevenly. Moreover, their production and industrial structure varied over time (Moretti [2012]). By 1980, the service economy was already twice as big as the non-service sector and population had already migrated away from rural areas, but the overall picture may differ according to the state or county dynamics. The key is whether there is a correlation between population and size of the service economy. Did counties that performed negatively depend on agriculture more than proportionally? Did those that increased their population and production depend on services more than proportionally?

3.5 The new long-term series of concentration indexes

3.5.1 Concentration and localization indicators

An alternative way to present information and avoid the bias of indicators on population size is the use of Locational Gini indexes as exemplified by Krugman (1999). As explained in Section 3, this indicator is analogous to the traditional Gini Coefficient, where individuals are counties and income are workers. Instead, the Locational Gini measures how disproportionately employment is allocated per county, taking the national values as reference. Overall sector Locational Gini Indexes for this period are shown in Table 3.3 below. Recall that this long-term series does not only provide unexplored insights into the service economy, but also avoids biases on data using counties instead of aggregated geographical scales.

Table 3.3: Long-term Locational Gini coefficients by sector

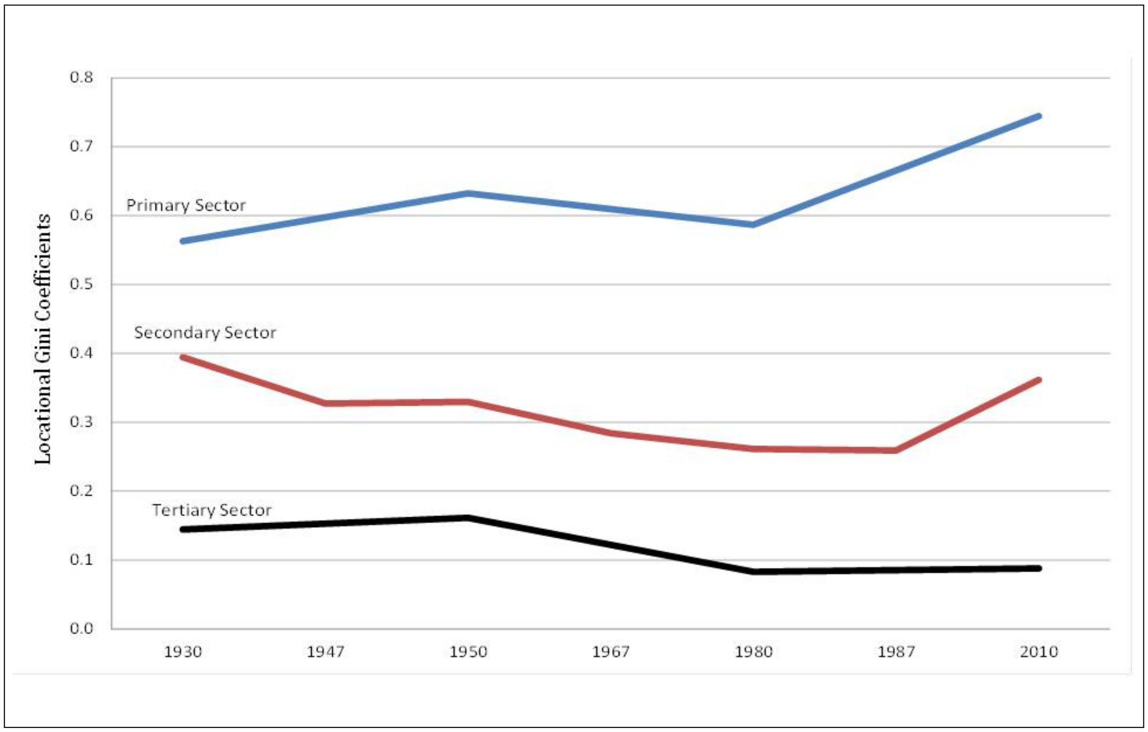
Sector	1890	1930	1950	1980	2010
Primary	-	0.563	0.632	0.587	0.744
Secondary	0.280	0.394	0.258	0.206	0.244
Tertiary	-	0.144	0.161	0.083	0.088

Source: own calculations from US Census records.

The initial assessment of the aggregate Locational Gini coefficients is in accordance with academic consensus: the disproportion for the primary and the secondary sector is higher than for services, on aggregate. Figure 3.5, however, shows the trend of aggregate services to diverge from the initial hypothesis. The service sector was expected to become more concentrated through the 20$^{\text{th}}$ century but locational inequality has decreased through the century, showing that service employees have become more spread.

The long-term growth of the service economy has absorbed a large share of the labor force growth. The simultaneous movement of population from rural to urban areas indicates that the service economy is absorbing most of the labor force. The analysis of industrial dynamics undertaken by Ellison and Glaeser [1999] shows that declining industries tend to concentrate more by reducing the number of plants to those where production is most efficient, which is what has happened in the manufacturing sector from the 1980s and the primary sector during the whole period. In other words, crowded (urbanized) counties have grown more and this growth is based on the service economy. As urban areas are geographically spread across the US geography, so too is the service economy. But are all services growing at the same rate? A more detailed look at the service economy might lead to results in favor of the original hypothesis.

Figure 3.5: Aggregate long-term Locational Gini coefficients



Source: own calculations from US Census data.

These detailed data show a contrasting evolution across different services: while distributional and personal services tend to remain spread, business services show higher inequality indicators. Within sector inequality seems a relevant issue since the production function of services seems to be so heterogeneous. In fact, Locational Gini coefficients in Figure 3.6 identify that certain service subsectors have managed to overcome the level of concentration of Manufacturing since 1980.

3.5.2 The tertiary sector in detail

A more detailed analysis of employees by industries requires more attention. Traditionally, manufacturing has been analyzed emphasizing the production of durable and non-durable goods.This is not a fanciful choice: first, the production of durable-goods tends to yield greater value added and margins; second, the production of both kinds of goods are usually tied to the provision of certain inputs (like metals or chemical products) which could lead firms to locate close to natural resource endowments; and third, their ties to customers and transport costs differ.

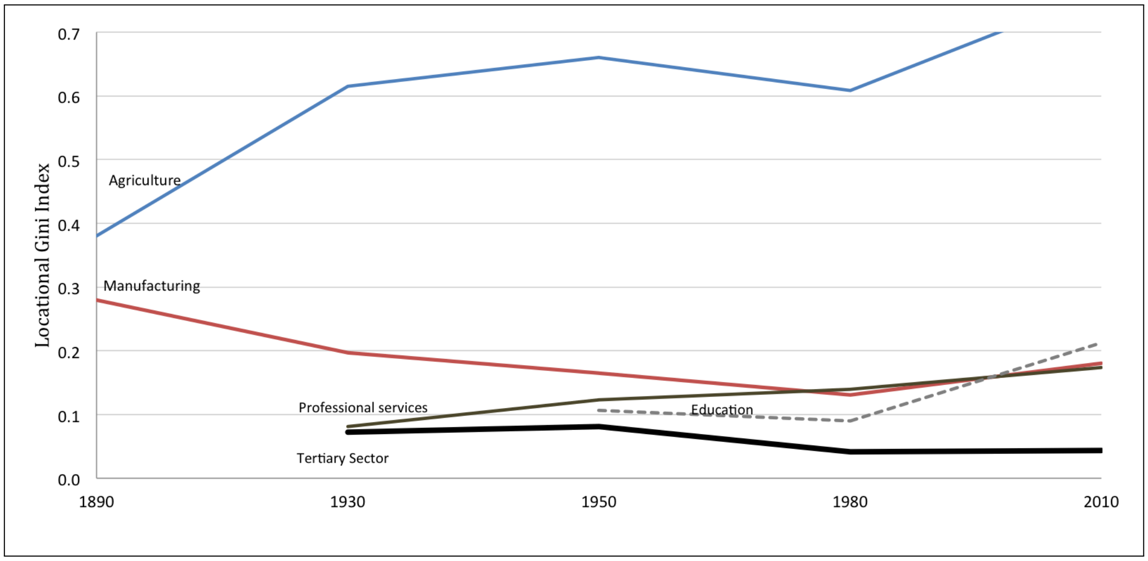
Considering the service sector as a whole seems to align the characteristics of service producers, leading to an unclear and biased vision of the sector and the general economy. This effect can be reduced by distinguishing services that share certain characteristics, such as the low cost of distribution or the nature of demand. Thus, we find that distributional (Utilities and Trade), personal (General Merchandise, Repair Services...), and knowledge intensive services (like Business and Professional services) can be followed through the analysis of Table 3.4 and in accordance with the classification shown in Table 3.1.

(a) Concentration within services

Figure 3.6 displays the service sector in detail and puts it in the context of the aggregate indicators. Note that Professional Services (KIBS) and Education (also knowledge intensive) are increasing and since 1980 have managed to surpass the concentration level of manufacturing. These sectors are not the only ones overtaking manufacturing. In fact, services whose employees are highly skilled and require an intensive knowledge in the industry are becoming more unequally distributed according to 3.5. These include Education, some financial services (the so-called FIRE) and, of course, KIBS. Higher education is paired with the pattern of research employees (within Professional Services) whose locational coefficients progressively escalate through the period. Other services like Entertainment behave likewise while distributional and personal services exhibit low coefficients through the whole period.

Concentration trends are heterogeneous within the sub-sectors of the service economy and contrasting with the aggregate trends of services. However, if aggregate trends are consistent with industry growth dynamics (increasing sectors tend to spread and declining sectors tend to concentrate), how can we reconcile these diverging trends?

Figure 3.6: Long-term Locational Gini coefficients



Source: own calculations from US Census data.

The answer lies in the fact that specialization and concentration do not necessarily move together (Aiginger and Davies [2004]). First, knowledge intensive sectors tend to concentrate where they can benefit from knowledge spillovers, and this happens when information moves fast: when firms and workers are geographically close, i.e. in highly urbanized areas. This means that cities have become more equal and the gap between rural and urban areas has become much more severe, as pointed out by Desmet and Fafchamps [2006]. Second, the impact of external economies is local; because cities are scattered across the US territory and states, the effect of concentration on the upper tail of the distribution is diluted. This explains why analyzing these sectors by state leads to conclude that services are proportionally spread.

Table 3.4: Descriptive statistics of employment data by industry

Industry	Mean Dev	CV	Log SD	Gini	GE(0)	GE(1)	GE(2)	Between State	Within State
Agriculture	0.363	1.694	1.075	0.512	1.655	0.559	1.434	0.26	0.74
Forestry & fishing	0.627	2.652	1.413	0.792	2.952	1.067	3.517	0.31	0.69
Mining	0.643	4.231	1.750	0.803	8.058	1.526	8.947	0.06	0.94
Construction	0.571	3.241	1.339	0.726	3.255	1.279	5.252	0.08	0.92
Food & kindred products	0.605	3.310	1.698	0.768	7.511	1.320	5.475	0.08	0.92
Textile mills	0.649	3.996	1.963	0.817	15.637	1.529	7.981	0.12	0.88
Printing& publishing	0.699	4.653	1.781	0.849	11.020	1.890	10.820	0.09	0.91
Chemical & allied	0.718	4.180	1.927	0.867	14.942	1.815	8.731	0.15	0.85
Primary metal	0.710	5.015	1.961	0.870	16.222	1.884	12.571	0.08	0.92
Furniture & wooden prods.	0.540	3.115	1.684	0.717	7.507	1.105	4.850	0.10	0.90
Fabricated metal	0.676	4.692	1.861	0.839	12.410	1.718	11.003	0.08	0.92
Electrical machinery	0.728	5.899	2.046	0.880	22.342	2.079	17.395	0.06	0.94
Other machinery	0.685	4.107	1.910	0.840	15.465	1.758	8.432	0.11	0.89
Transportation equipment	0.748	6.317	2.007	0.890	23.083	2.221	19.944	0.07	0.93
Railroads	0.638	3.625	1.623	0.799	5.806	1.444	6.569	0.04	0.96
Trucking & warehousing	0.599	3.528	1.473	0.755	4.554	1.380	6.223	0.08	0.91
Other transportation	0.713	5.013	1.556	0.850	7.091	2.056	12.558	0.08	0.92
Communications	0.690	6.324	1.716	0.840	9.713	1.976	19.988	0.04	0.96
Utilities	0.578	3.112	1.436	0.738	3.858	1.278	4.842	0.10	0.90
Wholesale trade	0.647	3.982	1.552	0.796	6.991	1.632	7.927	0.08	0.92
General merchandise	0.668	3.863	1.773	0.820	10.311	1.661	7.459	0.08	0.92
Food & bakery stores	0.587	3.235	1.406	0.742	3.735	1.319	5.231	0.12	0.88
Automotive & gas. Dealers	0.558	3.099	1.344	0.714	3.159	1.206	4.800	0.09	0.91
Eating & drinking places	0.631	3.499	1.537	0.782	5.295	1.481	6.119	0.11	0.89
Repair services	0.598	3.693	1.398	0.752	3.644	1.399	6.816	0.09	0.91
Private households	0.586	4.006	1.427	0.752	4.061	1.456	8.023	0.08	0.92
Other personal services	0.615	3.580	1.457	0.770	4.528	1.469	6.406	0.11	0.89
Health services	0.606	3.348	1.498	0.761	5.518	1.396	5.601	0.12	0.88
Hospitals	0.650	3.835	1.649	0.803	9.378	1.609	7.352	0.10	0.90
Elementary schooling	0.606	3.174	1.400	0.754	3.478	1.344	5.035	0.12	0.88
Other education	0.655	4.424	1.462	0.806	4.369	1.674	9.783	0.09	0.91
Entertainment	0.709	6.321	1.726	0.858	10.206	2.108	19.968	0.06	0.94
Banking & credit agencies	0.663	4.356	1.493	0.809	5.515	1.746	9.483	0.09	0.91
Insurance and real estate	0.719	4.490	1.756	0.857	11.940	1.977	10.076	0.10	0.90
Business services	**0.747**	**5.053**	**1.883**	**0.881**	**17.664**	**2.153**	**12.763**	**0.09**	**0.91**
Professional services	**0.721**	**4.752**	**1.712**	**0.858**	**10.564**	**2.019**	**11.285**	**0.10**	**0.90**
Social services	0.636	3.576	1.518	0.787	5.348	1.528	6.391	0.12	0.88
Public administration	0.646	3.406	1.451	0.791	4.323	1.548	5.798	0.18	0.82
Total activity	0.601	3.473	1.338	0.751	3.003	1.389	6.028	0.10	0.90

Source: Own calculations based on employment data per county from US Census records.

Table 3.5: Long-term Locational Gini coefficients by industry and county

Sector	1890	1930	1950	1980	2010
Primary	-	0.563	0.632	0.587	0.744
Agriculture	0.380	0.615	0.660	0.608	0.763
Forestry and fisheries	-	0.587	0.823	0.760	0.947
Mining	-	0.619	0.867	0.797	0.854
Secondary	0.565	-	0.258	0.206	0.244
Construction	-	-	0.220	0.221	0.232
Manufacturing	0.565	0.394	0.330	0.261	0.361
Tertiary	-	0.144	0.161	0.083	0.088
Utilities & communications	-	-	0.454	0.181	0.296
Transportation	-	0.095	0.292	0.212	-
Railroads	-	-	0.228	0.512	-
Trucking service & warehousing	-	-	0.429	0.232	0.338
Other transportation	-	-	0.318	0.323	-
Communications & Public Utilities	-	-	0.243	0.212	0.296
Telecommunications	-	-	0.225	0.283	0.345
Utilities and sanitary services	-	-	0.299	0.245	0.623
Trade	-	0.170	0.157	0.115	0.122
Wholesale trade	-	0.540	0.124	0.233	0.257
Retail trade	-	0.272	0.134	0.117	0.148
General Merchandise	-	-	-	0.172	-
Food, bakery & dairy stores	-	-	0.208	0.183	-
Eating and drinking places	-	-	0.146	0.154	-
Automotive and gasoline dealers	-	-	-	0.237	-
Other retail trade	-	-	0.347	-	-
Personal services	-	-	0.182	0.111	0.113
Repair services	-	-	0.186	0.166	0.200
Private households	-	0.147	0.330	0.313	n.a.
Hotels and lodging places	-	-	0.192	-	0.169
Entertainment and recreation	-	-	0.294	0.343	0.324
Health Services	-	-	0.257	0.159	0.167
Hospitals	-	-	-	0.207	0.340
Medical and other health	-	-	-	0.168	0.177
Education	-	-	0.212	0.089	0.426
Elementary Education	0.294	-	0.212	0.185	0.361
Higher education	-	-	-	-	0.675
Other education	-	-	-	-	0.363
Other personal services	-	-	0.399	0.217	0.187
Social Services	-	-	-	0.170	0.244
Finance, Insurance, Real Estate	-	-	0.433	0.224	0.258
Insurance and Real Estate	-	-	-	-	0.266
Insurance	-	-	-	-	0.322
Real Estate	-	-	-	-	0.256
Banking and Credit agencies	-	-	-	0.188	0.399
KIBS	-	-	0.293	0.278	0.255
Business services	-	-	0.186	0.313	0.248
Professional services: Legal, engineering & other	-	0.162	0.245	0.279	0.347
Clerical occupations	0.542	0.249	-	-	-
Public Administration	-	0.182	0.337	0.295	0.223
Industry not reported	-	-	0.234	-	0.760

Source: own calculations from US Census decennial records on county employment by industry.

In this sense, looking at the distribution of sectors through a smaller unit might help understand the localization of the service economy better. Again, Table 11 in the appendix shows General Entropy indexes that produce similar conclusions as the Locational Gini coefficients. The interest of this table lies in the perfect decomposability by group property of the GE index. This way, the table shows the group decomposition of the General Entropy index GE(2), considering predominantly the distribution in the upper tail, and proves that for any sector within services, the county effect is more important. The between-state effect seems to affect only non-service industries, showing a decreasing and low impact on the distribution of services, which explains why most researchers tend to find uninteresting results when analyzing the service economy. To prove that knowledge intensive sectors are concentrated in the upper tail of the distribution, a more detailed analysis of inequality needs to be performed.

(b) Localization of service sub-sectors

Fortunately, Hoover's index of localization allows an accurate analysis of the geographical shape of the inequality distribution of each industry. This measure explains where the intensity of disproportion occurs, providing an indicator per industry j and county i ranging between zero and infinite. To show this information effectively, I take advantage of maps that provide a visual idea of the distribution of sectors across the US and allow for the clear identification long-term patterns.

In general, sectors with extreme disproportions like Agriculture, Forestry and Fishing, Mining, and Railroads contrast with sectors like Wholesale Trade, Insurance, and aggregate services, which display low maximums. On the contrary, spread sectors like Elementary Schooling and Public Administration offer a positive minimum Hoover's index. This indicates that sectors in which production is related to a geographically fixed input (natural resources) must be localized where the resource is available, while for others there has to be some supply, no matter how small the county is. Data for the latest benchmark year (not-reported) reveal that maximum Localization coefficients are even higher for almost all sectors, showing an exacerbation of trends in the long-run.

In this sense, when a county holds a very high disproportional allocation of employees relative to national values, it will be represented as a red hot-spot. If the county is shown blue, the disproportion will be negative. Note that HI=1 is associated with close to perfect proportion scenarios: no localization, no specialization, and no comparative advantage. An industry in which the share of employment is similar to national values in all counties (i.e., share of employment in industry i is constant across all counties) would generate a white map. The proceeding text describes the evolution of the geographical distribution of disproportions across sectors.

The evolution of the primary sector is shown in Figure 3.7. Both maps reveal that disproportions are high and scattered. Further, these seem to be affected by strong state effects, in accordance with previous findings. Additionally, it seems that counties with high shares of agriculture have increased their disproportion further from 1930 to 1980. In other words, even with a decrease in the aggregate share of primary sector employment, the localization of agriculture has persisted through time where there was an initial advantage (such as the central region of the US with vast land and mineral resources), which is a typical argument in the economic geography literature.

The secondary sector shows a completely different picture. Initially, Hoover indexes for the secondary sector indicate that most of the industrial production of the nation takes place in very few counties in 1930. Figure 3.8 shows a large blue area with a few scattered red groups of counties with no strong state effects. By 1980, the geographical distribution of secondary sector employment spread more proportionally. The manufacturing belt dissolved and the remaining industry clusters were localized in New Mexico. Part of the explanation of this behavior lies in the decline of manufacturing in the US, much to the benefit of other countries and sectors. It is highly probable that the analysis of a very specific industry, say microchips, would draw a less proportional map as the ones described by Krugman [1991].

The distribution of services exhibits a more striking evolution. Figure 3.9 shows low and scattered disproportions across the whole US geography; service employees look proportionally distributed on average and there is no evidence of state-effects. By 1980, the disproportion changes in favor of the eastern region of the country as light-red areas have remained on the right side of the map, while the service workers in the west seem to allocate more proportionally. Although the coefficients are greater than one, localization is low because services are everywhere: distributional services provide access to every single agent (in a developed country); thus, these are conveniently dispersed. Accordingly, locational Lorenz curves are very close to the proportion line, with a locational Gini equal to 0.08 for General Merchandise and 0.09 for Wholesale Trade in 1980.[15]

Similarly, personal services are delivered on demand (hospitals, schools, hairdressers, car-washers...). These services also exhibit relatively high fixed costs and low marginal cost, however in this case consumers consider not only heterogeneity of supply, but also transportation costs. Therefore, although these tend to spread across population they are more disproportionally allocated than distributional services; there is a higher supply of personal services in congested areas: the maximum bound of the localization index for Personal Services sub-sector for the whole period is 4.7, and for Banking 3.9 (which contrasts with the Mining sector's upper bound of 43). Thus, the initial hypothesis is tentatively confirmed by the Personal Service sector.

Nevertheless, there are heterogeneities within this sector that are worth mentioning. One of the most surprising findings is the high concentration of Private Household employees for the year 1980: the locational Gini index for Private Household employees equals 0.313 in 1980. According to the only accurate and available cross-section on this sector for the whole period, Private Household employees are highly localized in the south of the country (specifically in Texas, Louisiana, Mississippi, Alabama and Georgia where the highest, above 10, locational indexes are shown). This sharp clustering is difficult to explain in the framework of external or internal economies of scale. Alternatively, exogenous forces like institutions and traditions might explain this behavior. These conjectures could also be applied in the case of Entertainment (highly localized in California, Nevada, Florida and New

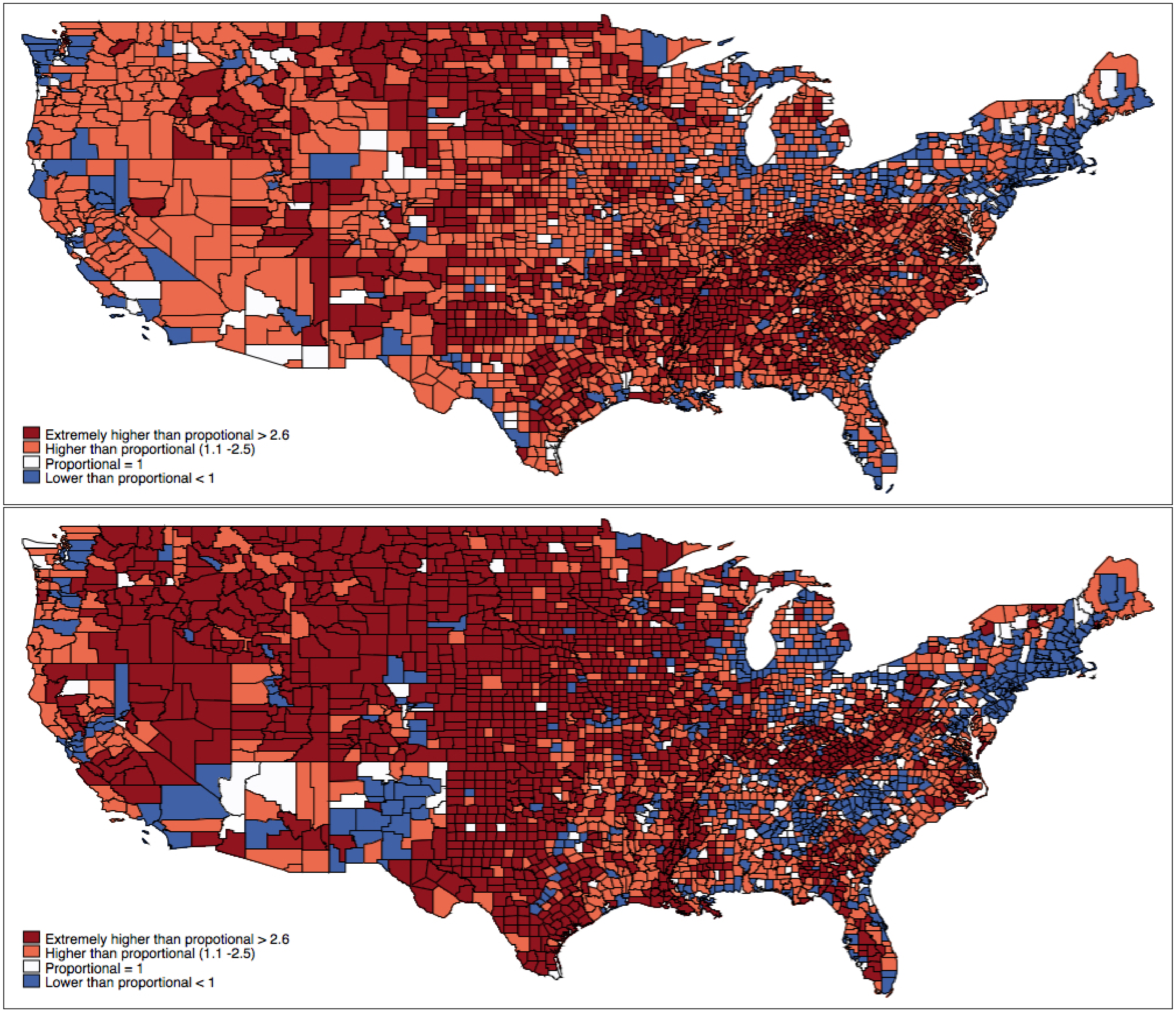
[15] Figure 3.4 shows the locational Lorenz curve for Health services.

York, with a higher state component than other sectors) that may have been geographically determined by the prohibition of gambling (Nevada was the first state to legalize gambling in 1931 after the signing of the Assembly Bill 98).

When considering Knowledge Intensive Services, the results become much more interesting, showing a higher localization index than the tertiary sector on average by 1930. This is a natural effect of using a narrower sector; however, Knowledge Intensive services do show the highest locational Gini's among any services in all benchmark years. The results for 1930 (in Figure 3.10) describe an initial situation with an almost proportional allocation of Knowledge intensive employees, where small groups of counties with greater than proportional allocations are scattered along the map. By 1980, the disproportion had become more acute. Counties in which the allocation of Knowledge Intensive employees was initially proportional showed a lower than proportional amount of high skill workers (blue) in 1980. Conversely, counties in which the initial proportion of skilled jobs was relatively high absorbed an ever greater share, probably draining the skilled labor force from the initial blue area.

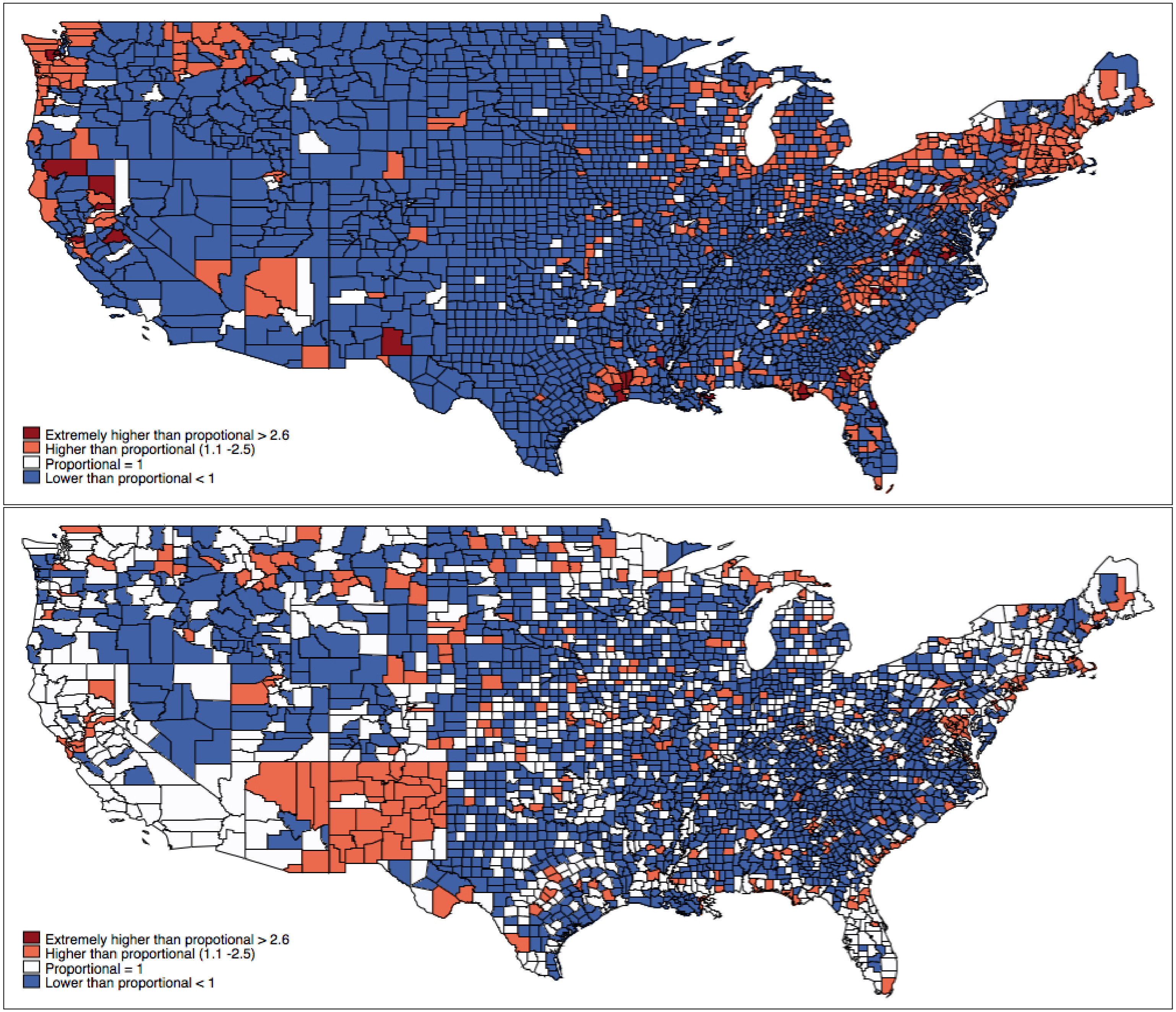
The results from 2010 are even more striking in Figure 3.11, where SMSAs are also shown. Knowledge service firms locate around cities such as New York, Massachusetts, Chicago and other metropolitan areas, their presence fading in less congested areas. This implies that the strength of external economies in this sector is highly relevant while the effect of transaction costs is negligible. The growth of the Knowledge Intensive Business Sector only happens in areas where it will survive through externalities as Ciarli et al. [2008] and Kim [1999] suggest.

Figure 3.7: Location coefficient of primary sector - 1930 and 1980



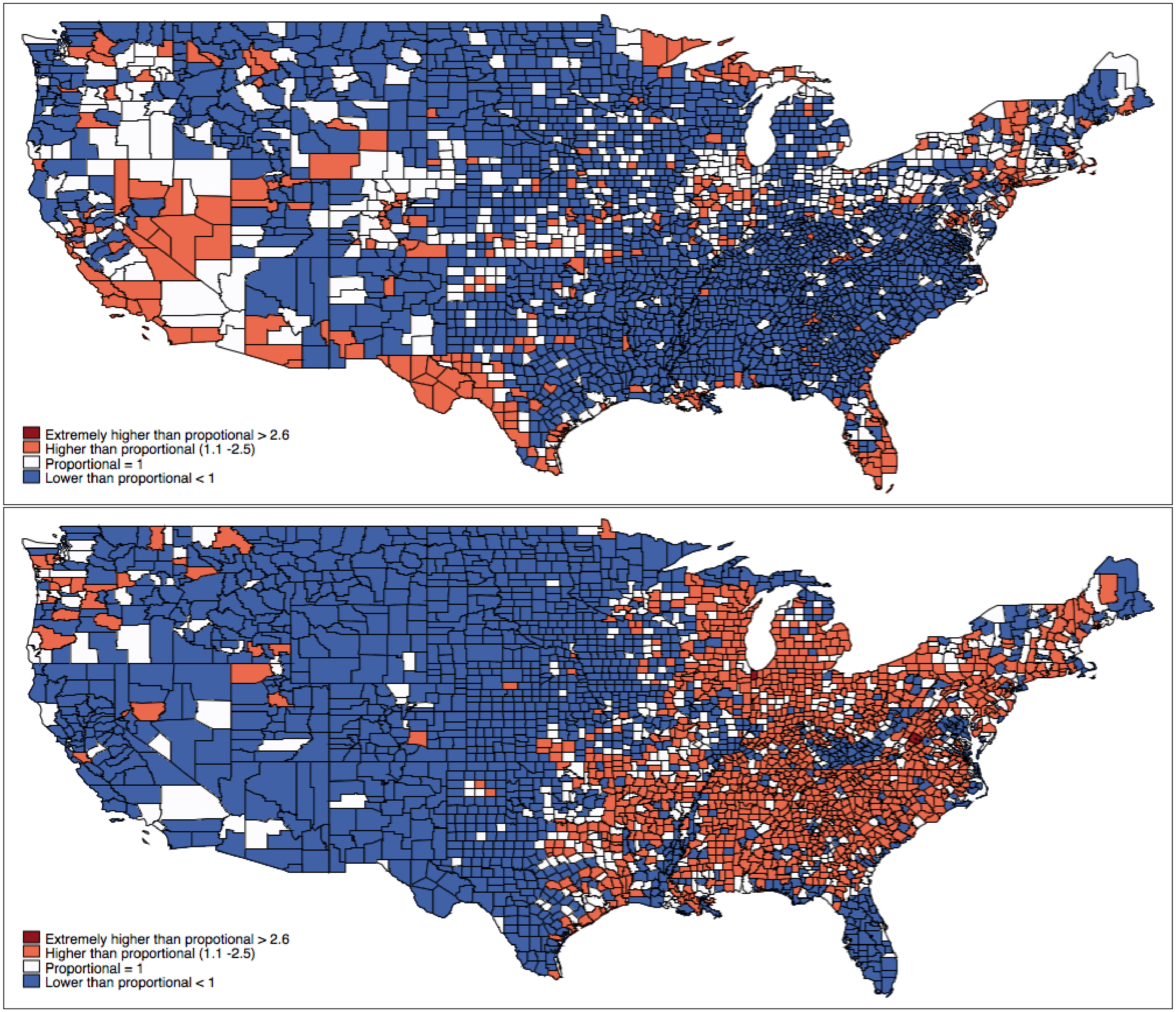
Source: own calculations from US Census data.

Figure 3.8: Location coefficient of secondary sector - 1930 and 1980



Source: own calculations from US Census data.

Figure 3.9: Location coefficient of tertiary sector - 1930 and 1980

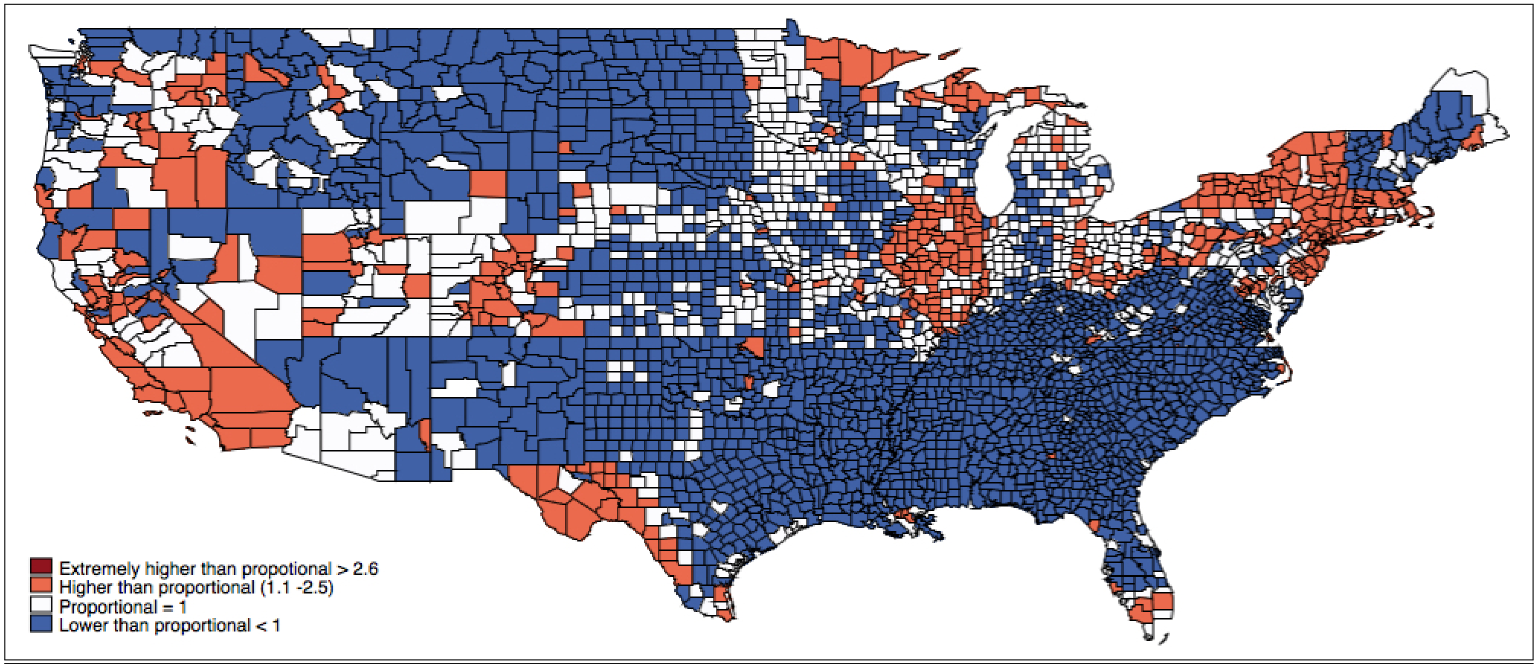


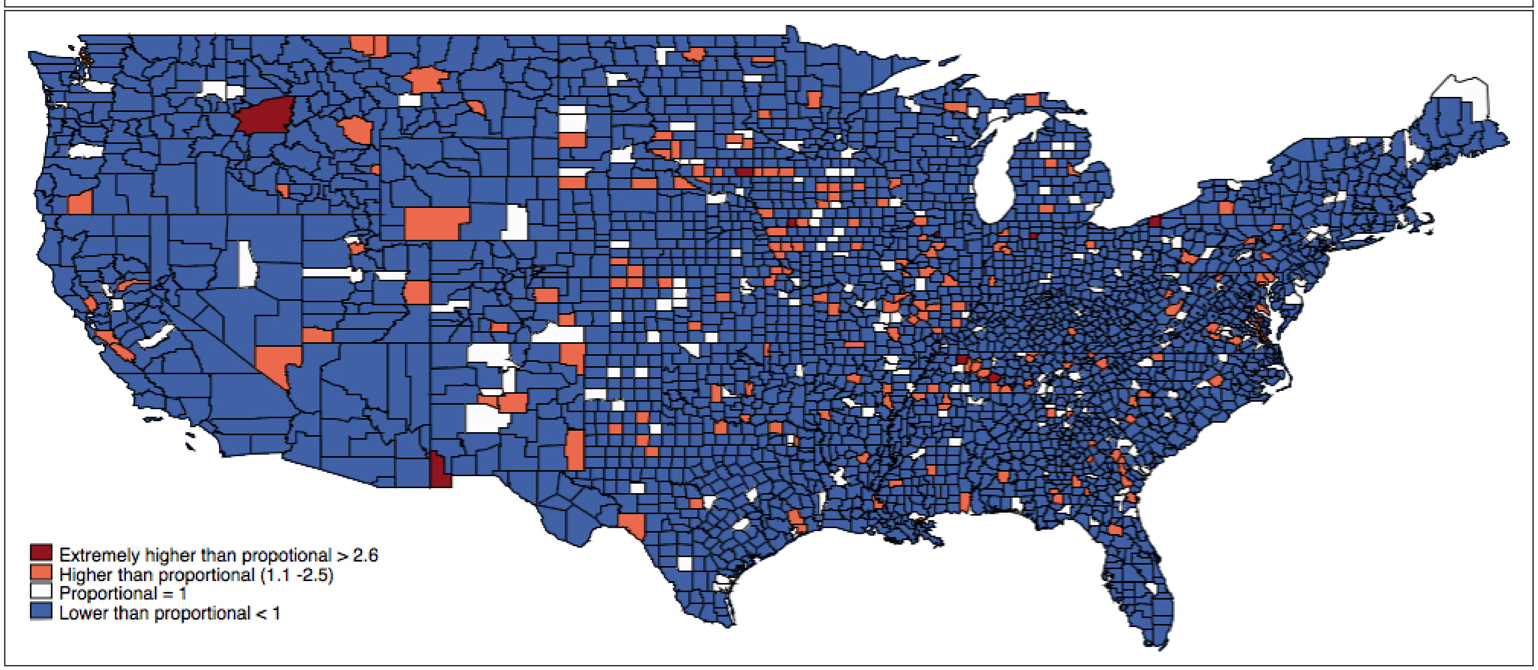
Source: own calculations from US Census data.

The clustering of KIBS is not only related with externalities, but also with the nearly costless transmission of such knowledge. As discussed by Venables [2001], "the death of distance" allows companies in New York State to provide services to industries in Kentucky. These findings suggest 1) a migration movement of skilled employees from rural to urban counties and 2) that the supply of knowledge intensive services for the country can be provided by five or six very productive clusters.

Additionally, the impact of external economies can be explored through the differences between Elementary Schooling and Higher Education, which differ substantially in the intensity of their knowledge component. The upper bound of the locational index for Higher Education employees through the whole period doubles the highest one for Elementary Education. Furthermore, while Elementary Education shows no geographic pattern (recall it is one of the counties with a minimum location coefficient greater than zero, i.e. there is supply in all counties regardless of population size), Higher Education is clearly localized in the North-Eastern and Western (Pacific) regions of the country parallel to the manufacturing belt and Silicon Valley. It follows that knowledge intensive education tends to concentrate more than elementary education; this proves that knowledge intensity fosters agglomeration among peers (Marshallian externalities). Jacobian externalities could also explain localization in these regions. Counties where Higher Education is present are also great knowledge intensive industrial producers; in fact, between sectors correlation indicators show that the highest significant correlation for Higher Education is Professional Services, followed by Business Services, which are low but positive and significant. These findings support the IRS in knowledge intensive services and are in accordance with the argument proposed by Moretti [2012].

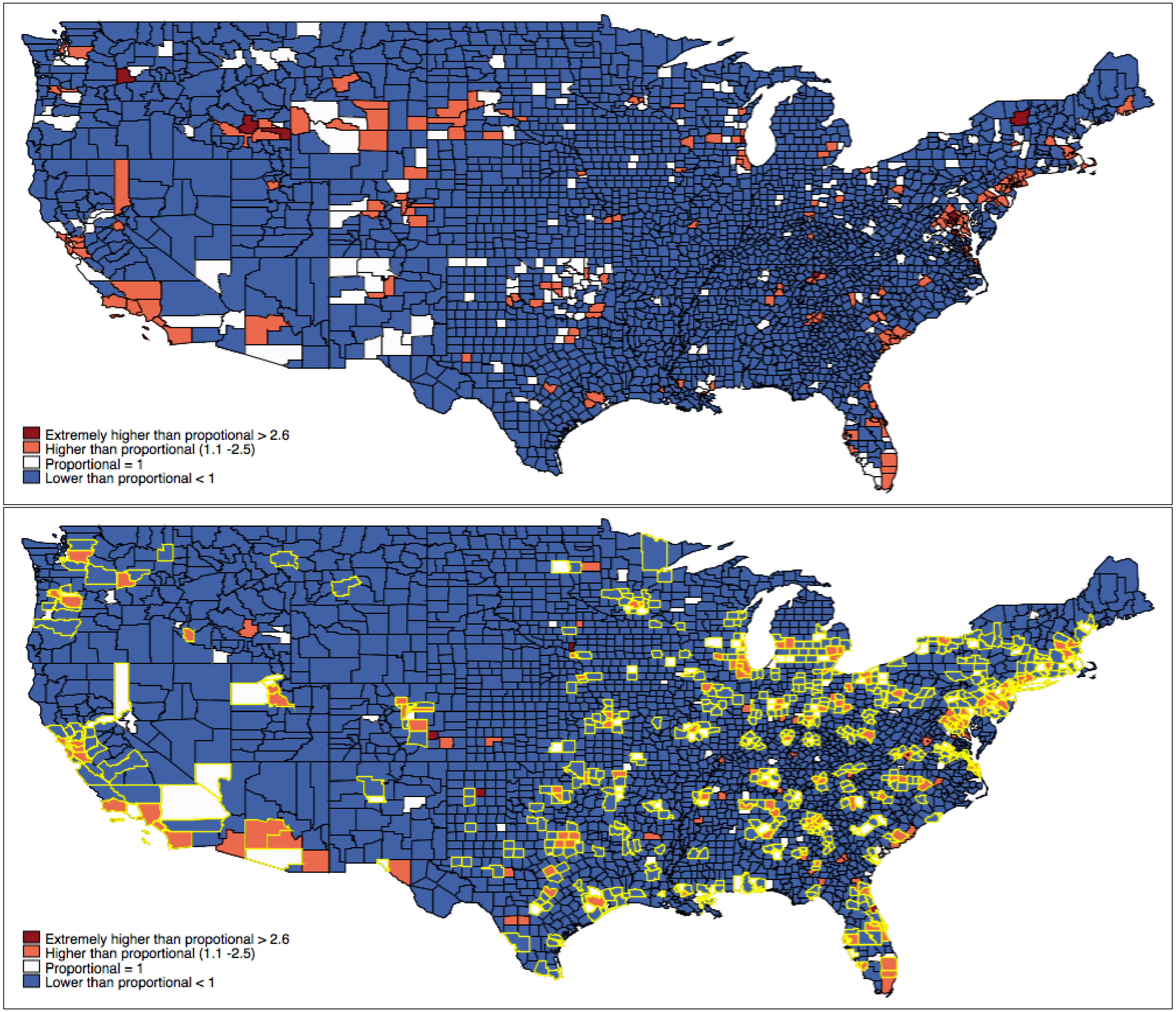
Figure 3.10: Location coefficient of KIBS - 1930 and 1980





Source: own calculations from US Census data.

Figure 3.11: Location coefficient of KIBS for 1950 and 2010 with SMSAs



Source: own calculations from US Census data.

3.5.3 The polarization of the economy

The previous section provides empirical evidence of the increasing inequality between "the two Americas" described by Desmet and Fafchamps [2006] and Moretti's [2012] analysis: the rural stagnating regions and the increasingly crowded skilled economy. Recently, Yamamoto [2007] identified polarization as a worthwhile indicator for fully comprehending income distributions. In this context, increasing polarization implies the clustering of the distribution of employment by industry across similar counties and away from counties with antagonistic characteristics. Although Yamamoto [2007] did not find evidence of income polarization in terms of counties, and the hypothesis is to find the same conclusion, it is worth analyzing whether the distribution of employment is behaving likewise and examining different behaviors across sectors.

In Esteban and Ray [1994]'s words, a polarized distribution means: 1) a high degree of homogeneity within groups, i.e., rural counties must share similar characteristics and urban counties, too; 2) high heterogeneity across groups: rural and urban counties must be markedly and increasingly different; and 3) the number of groups must be small and big enough to affect the distribution: in this sense, counties should be easily classified as rural, small towns and/or big cities. Following their methodology, Table 3.6 shows the ER polarization index by industry and its rank across time.

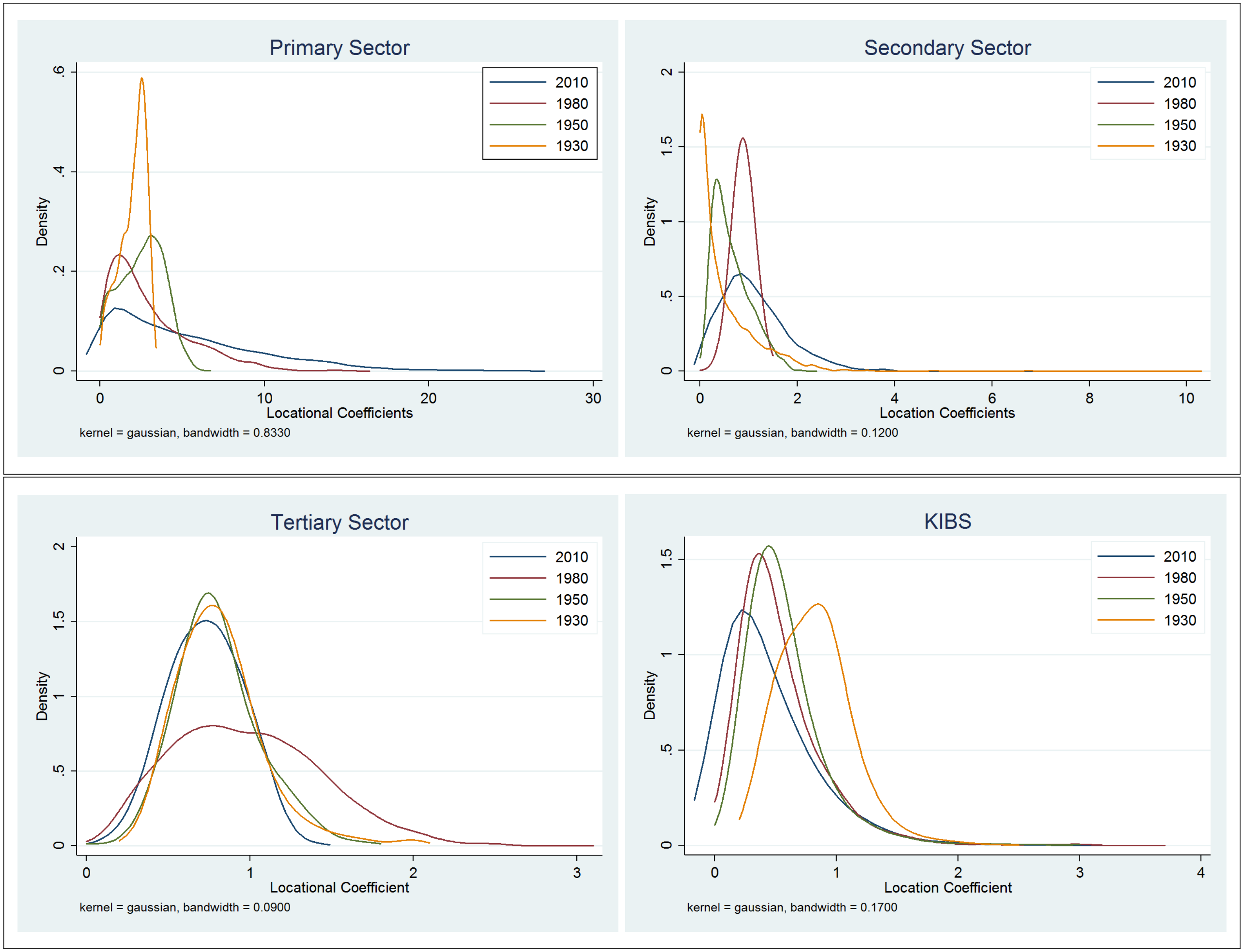
The table shows that the distribution of the primary sector has remained the most uniform sector over time. The service economy has become the most clustered sector, at least since the 1980s (depending on the alpha-sensitivity to polarization chosen), while the distribution of the secondary economy, which showed the most polarized distribution in 1930, has become less extreme. The index of polarization can be explained through the identification-alienation strategy proposed by Duclos et al. [2004]. This strategy simply aims to measure the degree of homogeneity between groups (identification) and the differentiation across groups (alienation) that can easily be seen by using a frequency histogram of the distribution as shown in the different examples explained in Esteban and Ray [1994]. Figure 3.12 shows the kernel probability distribution estimates of the locational coefficients by sector over time. According to this data, probability distributions are widely uni-modal with a high identification component in the main group, showing a low polarization that agrees with the data from Table 3.6.

Table 3.6: Polarization indexes and ranks by sector and year

	alpha=1.0						alpha=1.3						alpha=1.6					
	1950	r	1980	r	2010	r	1950	r	1980	r	2010	r	1950	r	1980	r	2010	r
Primary Sector	**0.017**	**3**	**0.018**	**3**	**0.014**	**3**	**0.005**	**3**	**0.006**	**3**	**0.004**	**3**	**0.002**	**3**	**0.002**	**3**	**0.001**	**3**
Agriculture	0.017		0.023		0.015		0.005		0.007		0.004		0.002		0.002		0.001	
Mining	0.174		0.122		0.109		0.109		0.067		0.057		0.070		0.038		0.031	
Foresty & fishing	0.113		0.046		0.039		0.061		0.018		0.015		0.034		0.008		0.006	
Secondary Sector	**0.058**	**1**	**0.031**	**2**	**0.034**	**2**	**0.028**	**1**	**0.019**	**1**	**0.014**	**2**	**0.014**	**1**	**0.012**	**1**	**0.006**	**2**
Manufacturing	0.089		0.044		0.042		0.046		0.018		0.017		0.024		0.008		0.007	
Construction	0.032		0.013		0.040		0.016		0.013		0.018		0.008		0.006		0.008	
Tertiary Sector	**0.036**	**2**	**0.034**	**1**	**0.041**	**1**	**0.020**	**2**	**0.015**	**2**	**0.022**	**1**	**0.011**	**2**	**0.006**	**2**	**0.012**	**1**
Personal Services	0.036		0.034		0.038		0.020		0.019		0.020		0.011		0.011		0.010	
KIBS	0.060		0.068		0.107		0.032		0.036		0.060		0.017		0.020		0.035	

Esteban and Ray's polarization index and ranks. *Source: own calculations from US Census data.*

Figure 3.12: Kernel Density Estimation by sector



Source: from author's own calculations.

The primary sector seems to have suffered in terms of identification among the counties with relatively lower advantage as the highest point of the density function has decreased and the distribution has flattened: the counties that had the greatest advantage have remained at the right-hand tail of the distribution, and this has spread further (in 1930, around 40 per cent of the counties had a slight comparative advantage in agriculture with a localization index between 1.9 and 2.9; in 2010 the disproportion has increased to a maximum localization index of 26.2 and the counties above 1.9 are less than one per cent). Although the right-hand tail of the distribution has become more extreme, it is very difficult to establish common characteristics between those away from the mode, as they are very uniformly spread showing no alienation.

In contrast, the secondary sector change is characterized by lower alienation. The mode of the secondary employment distribution is close to perfect proportionality at LC=1. Those at the right-hand side tail of the distribution are now even closer, therefore the distribution of manufacturing employees has become even less polarized in accordance with the rank evolution of ER indexes.

The tertiary sector is perhaps the most interesting one. The modality around a proportional distribution of service employment across counties is also confirmed. However, in this case, those with a relative advantage have increased it over time. This is particularly evident by looking at the Knowledge Intensive Business Service employment distributions: the mode remains below 1, but counties at the tail (a minority) have multiplied their locational coefficient more than three-fold. In other words, the vast majority of counties belong to a group with low knowledge comparative advantage, while a small minority is becoming more and more different over time, increasing the alienation between them but having a low impact on the ER polarization index because they belong to a very small group.

Although there are palpable differences across sectors in terms of polarization and its distinct components, the low polarization in the income distribution across counties found by Yamamoto [2007] corresponds to these findings with respect to employment distribution by sectors across counties. These findings confirm that a small number of counties are becoming extraordinarily different over the period, extending upper tail on the curve but with low power to change the shape of the distribution of locational coefficients. The privileged low number of counties with a slight advantage to urbanize, urbanize more and faster, leaving the rest behind, increasing inequality indicators but keeping polarization indexes low. These findings clearly confirm the relevance of the concepts discussed by Duclos et al. [2004]; Esteban and Ray [1994].

3.5.4 Spatial autocorrelation

Economic Geography links space to the distribution of markets and industries. A very useful tool to measure these distributions is spatial correlation, which can be properly defined using Moran's index of spatial autocorrelation in its various forms. Very simply, Moran's index shows a value of an individual relative to the values of neighboring individuals. In practice, Moran's index requires the development of a neighboring matrix to determine spatial proximity across all individuals and predict a correlation of the variable in question based on proximity rather than time. This matrix can take several forms and orders. Here I use an order one Queen-contiguity matrix, which provides a value equal to one if two counties are touching through a border or a vertex and zero otherwise.

Through this proximity matrix, Moran's index considers each region's position relative to all of the others, providing information on agglomeration that Krugman's index ignores. This index, however, provides a higher spatial correlation index when adjacent regions are correlated than when non-adjacent but proximate regions are correlated ([Missiaia, 2014, page 56] for further illustration).

Table 3.7 shows Global Moran indexes for each year and sector. Each observation is an average indicator for the whole sample, assuming all the regions (counties) in the US are internally homogeneous. This assumption, however, might be realistic for many counties and completely unrealistic for others (for example, big urban areas might be so big that they are composed by several counties that are internally homogeneous, while more uncongested counties can be locally heterogeneous).

These data provide higher Moran indexes for the primary sector than for the rest of the economy. Spatial correlation is increasing and persistent through time for the localization of agricultural producers. Spatial autocorrelation is smaller for the secondary sector and variable for the service economy. Using a narrower industry classification, the trends for agricultural producers persist and the autocorrelation of Knowledge Intensive sectors increase.

In other words, the primary sector seemed geographically spread through the US economy, and looking at Moran indexes reveals that counties specialized in agricultural production were driven to further localization of agriculture. The optimal conditions for agricultural production are difficult to find in specific locations, but when these happen, the area tends to be wider: regions that benefit from valleys, mining settlements or good climate conditions are not local; therefore, the chance of an agricultural county located next to a big city specialized in the service economy seems low, while the chance of a county devoted to agriculture close to two or more agricultural counties seems much higher.

Table 3.7: Spatial autocorrelation measured by county units

Variable	Primary	Secondary	Tertiary	Agricultural	KIBS
1930	0.170	0.090	0.167	0.307	0.181
	(0.012)	*(0.010)*	*(0.010)*	*(0.009)*	*(0.011)*
1950	0.166	0.208	0.115	0.066	0.164
	(0.011)	*(0.011)*	*(0.011)*	*(0.010)*	*(0.011)*
1980	0.195	0.096	0.192	0.123	0.212
	(0.012)	*(0.011)*	*(0.011)*	*(0.011)*	*(0.011)*
2010	0.214	0.109	0.139	0.077	0.217
	(0.010)	*0.011*	*(0.011)*	*(0.011)*	*(0.011)*

Global Moran's index from simple regression coefficients of Location Coefficients by sector and county employment data on lagged Location Coefficients (neighboring regions). Standard errors reported under the coefficient, all the coefficients are significant at 99% confidence. *Source: own calculations from US Census data.*

On the other hand, counties might be too big to account for the proper conditions that service entrepreneurs need to find the synergies from knowledge spillovers, urban dynamics and labor markets. This local effect explains the lower global autocorrelation indicator of both manufacturing and knowledge services. The fact that the aggregate service economy seems to have a higher Moran index is related to the higher urbanization levels by state in the East than the West during most of the century, explaining a higher degree of personal and distributional services.

These aggregate results can be used to track the location of clusters in a similar way than in the previous section if we use local measures of spatial autocorrelation as explained by Anselin [1995]. These measurements provide an indicator per region and can be mapped just as in the previous sectors. However, these maps do not differ to a great extent. Using local spatial autocorrelation indexes we can identify that county clusters are persistent for the primary sector over all the benchmark years in the states of Nevada, California, Michigan and Mississippi at 95 per cent significance.

3.5.5 Industrial linkages

Spatial autocorrelation can also be linked to the regional specialization of a sector. This way, analyzing the specialization patterns of neighbors and its significance with the reference counties, we can assess whether industrial linkages might play some role in the local distribution of employment by industry. This is called the bivariate Moran's index and is the simple regression of locational coefficients of any industry with respect to the locational coefficient of neighbors on another industry. In other words, this regression measures the strength of the geographical distribution of employment in a sector on the locational distribution of another sector's employment.

Table 3.8: Correlation coefficient between log total employees and percentage employment by sector

	Primary Sector	**Secondary Sector**	**Tertiary Sector**
2010	-0.734	0.160	0.696
1980	-0.643	0.209	0.470
1950	-0.520	0.476	0.416
1930	-0.527	0.430	0.363
1890	-0.400	0.365	-0.084
Total	-0.525	0.246	0.483

Data source: Results from own calculations at 99% significance.

The first interesting point is that the significance of the bivariate Moran's index is much lower than the univariate calculation. The second point is that the bivariate Moran's between KIBS and the primary sector demonstrate a negative relationship consistent over all the benchmark years. The rest of the coefficients appear to show unimportant relationships. Interestingly enough, one can also look at the simple correlation coefficients shown in Table 9 in Appendix B and find a positive correlation between Business services and Professional services and Insurance sectors. However these simple correlations do not take into account nearby locations but rather simple coincidences in the same county.

From this appreciation a negative relationship seems to stand between agriculture and the success of the knowledge intensive economy. One explanation could be that the local external economies that sustain the knowledge economy cannot exist in a context of vast land resources, and therefore the knowledge economy and agriculture seem incompatible. That the primary and the tertiary sectors are negatively correlated is something that can be inferred with a mere visual inspection of Figures 3.7 and 3.9. However, this step can be further analyzed if we consider the growth dynamics and structural change of sectors. More simply, Table 3.8 assesses the correlations between the shares of each sector with total employment size in each benchmark year. The main implication is a negative correlation between the primary sector and the size of the labor market that increases over time. Meanwhile, the tertiary sector follows a completely opposite trend. The primary sector is becoming less labor intensive while labor is becoming a primary input of the service economy. These ideas and the allocation patterns previously depicted show that Rybczynski's theorem holds: counties produce outputs that are intensive in the factor that they are abundant in. Thus, counties with vast natural resources will specialize in primary products, while counties with big labor markets tend to use these intensively. Whether this is an effect of factor endowments or market size is beyond the scope of this chapter, but it is definitely worth an explanation in the next chapters.

3.6 Conclusions

This analysis has confirmed that a consideration of the service economy is essential to understanding the trends of concentration, specialization and localization of the global economy. This is true not only because of the magnitude of the sector in the overall economy, but also because recent trends affect the localization of the aggregate market. The specialization in services to the detriment of manufacturing implies that the relatively lower overall concentration has had more remarkable effects on general inequality. Although service employees are more diffused than both primary and secondary sector workers, the evolution of the service sector has changed in the last century, driving the trends of the market to change as well.

The picture among sub-sectors within services is rather heterogeneous. Since 1980, knowledge intensive services like Business Services, Professional Services, Entertainment and Higher Education have become more concentrated and localized, while distributional services and some personal services (Elementary Education and Health) have remained spread. This divergence indicates that there are differences in the shape of service production functions. For knowledge intensive sectors, knowledge spillovers, the size of the market and closeness to a specialized pool of labor (agglomeration economies) seem to be more important while transport costs and competition (agglomeration dis-economies) may discourage allocation of utilities and personal services where they are already present. Other factors could also determine the location of services where external economies are not so relevant but concentration levels are strikingly high. In the case of Private Household Employees or Entertainment in 1980, institutions are a likely determinant. The results derived from this analysis show that the Rybczynski theorem holds: counties produce outputs intensive in the factor they are abundant in. Thus, counties with vast natural resources will specialize in primary products, while counties with a relative big labor market tend to use this factor intensively. On the other hand, some evidence suggests that the primary sector allocates according to natural endowments and manufacturing industries are driven by externalities.

Moreover, it appears that specialization in certain industries may attract and repel other industries. On the one hand, knowledge intensive services seem to allocate in counties where Higher Education and Entertainment industries are also present, implying some arguments in favor of Jacobian externalities. However, the correlation between Agriculture and Mining and Manufacturing heavy industries seems to work in the opposite direction. Where a high share of the population is involved with primary sector activities, there is no place for knowledge intensive services, probably because in those conditions it is difficult to benefit from market size. The results shown in this chapter emphasize the multiplier effect of knowledge intensive service employment towards further growth in developed economies.

The narrower analysis of counties rather than wide geographical units has provided much better visibility and allowed for the identification of the local effect of external economies otherwise unseen. Analysis on a larger scale permits an understanding of agglomeration through wide aspects such comparative and natural advantages but overlooks the subtle local effect of externalities that enhance the local multiplier of services and explain local market differentials. The need to examine different scales in terms of inequality of distributions is also proven by Yamamoto [2007]. This explains why most research underestimates both the localization of the service economy and its effect on regional markets by inferring conclusions from an analysis that ignores 80 per cent of the value added and overlooks part of the distribution. Furthermore, these results call for a model that explains the determinants of these agglomeration patterns and that includes not only the service economy, but the new configuration of markets and nesting economic regions.

CHAPTER 4

The determinants of service employment localization in the long run

Economic historians tend to explain development gaps by focusing on the contrast between manufacturing and agriculture, overlooking the increasing role of services. This chapter analyses the causes of sectoral localization over the 20th century in US counties by placing emphasis on the service economy. Using census employment data by sector, I examine the debate on resource endowments and market size through county location coefficients. The model of localization is approached in three steps: first by showing that relative factors of production impact the geographical allocation of production. Then I show how technology modified the relationship between factors of production, making skills more important over time. However, when considering market potential the coefficients of factor endowments become insignificant. These results show that a two-way fixed-effects model appropriately explains the allocation of services, emphasizing geographical conditions that foster the growth of services and its persistence over time. Conclusions suggest that increasing returns determine sectoral localization of employment except when physical geography endowments are a constraint.

JEL classification: L8, N72, R12, O18.
Keywords: New Economic Geography, Market Potential, Service Location

4.1 Introduction

The study of the localization of economic activity has received much attention in the last few decades. The reason behind this interest is that many economists regard geographical concentration of industries as the driver of development differentials. Despite the great interest that specialization and concentration has raised, the study of the service sector has been barely analyzed, not even for the United States. This chapter examines the debate on the patterns of employment localization during the period 1930-2010 across counties in the United States, with careful consideration of the service economy.

The 20th century led to the geographical reallocation of economic activity from a national, regional and local perspective. In the case of the United States of America the diffusion of railways, telephones and the most recent ICT revolution pushed many economic activities away from the Manufacturing Belt to alternative regions.[1] One of the key ingredients of this shift in location is the gradual change in the specialization of the country from manufacturing to the service economy. The aim of this chapter is to provide a straightforward explanation of the long-term disproportional distribution of services in urban areas.

My contribution can be summarized by three findings: firstly, I find that Knowledge Intensive Business Services (KIBS as denoted by Ciarli et al. [2012]) tend to be disproportionally localized in densely populated metropolitan areas;[2] US Census Decennial data show that, since 1980, KIBS are more localized than some traditionally clustered manufacturing industries. Secondly, I find that the reason for this disproportion is related to the development of new technologies that have provided Increasing Returns of Scale (IRS) to the production function of

[1] Crafts and Klein [2012, p. 3] explain that the 'Manufacturing Belt' should be defined in terms of counties but roughly demarcate it as the area covered by the following states: Connecticut, Delaware, Illinois, Indiana, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia, and Wisconsin. For more information on the change in specialization patterns of these states check 'American Rust' in Moretti [2012].

[2] These are all the economic activities that use skilled labor intensively as a factor input. More specifically, services provided by skilled labor like research, professional services, marketing, etcetera. Note that international specialization has led to outsourcing of manufacturing to other countries and companies that were previously considered part of manufacturing in censuses are now computed as services. Because it is difficult to track these changes from census to census, the strategy is to consider aggregate sectors (primary, secondary and tertiary) and compare the results between these and personal and Knowledge Intensive Business Sectors which are perfectly defined from census to census and are easier to track.

services. Lastly, I find that Increasing Returns explain better the localization of non-agricultural economic activity and its effect doubles for knowledge intensive industries while factor endowments determine the localization of primary sector employment.

The debate on industrial localization is generally based on the study of the manufacturing industry. While some authors use the Heckscher-Ohlin framework based on factor endowments, others base their arguments on New Economic Geography (NEG).[3] This new trend moves away from perfect competition and argues that production functions are likely to develop increasing returns to scale and, thus, increasing demand is more important than resource availability. In the last decades, several authors have argued that these two approaches are not exclusive and, hence, should be considered together in the analysis of industrial activities.[4] However, the relative importance of HO factors and IRS determinants may vary across industries, being the latter more important for services than for agricultural production. This investigation combines the methodologies used by Krugman [1991], Kim [1995, 1999] and Ellison and Glaeser [1999] to study the patterns of manufacturing localization in the United States. More recently, the cases of Spain analyzed by Rosés [2003], Britain by Crafts and Mulatu [2005] and Italy by Missiaia [2014] have provided evidence in favor of the mixed model.

Approaching the service economy through these methodologies leads to the conclusion that transaction cost reductions from technology increased the share and value of aggregate services, fostering the agglomeration of knowledge intensive activities close to big markets. Making use of a new long-term series of industrial localization using counties as a geographic unit of analysis, I test a model of localization that considers both factor endowments and scale effects based on counties Market Potential. I provide support in favor of the size of the market to explain the localization of any activity with different weights across industries.

This chapter is organized as follows. The next section reviews the main trends of the literature explaining localization. Section 3 explains the singularities of the methodology and the data. Section 4 explains the results of the empirical analysis and presents some robustness checks, and Section 5 concludes.

[3] These opposing views are summarized in Kim [1995] and Krugman [1991].

[4] See, for example, Amiti [2005] and Epifani [2005], who embed relative factor prices based on endowments in a NEG framework to explain specialization at different geographical levels.

4.2 Empirical framework: theories and models

The literature on the geographical allocation of production dates back to classical economists who previously proposed comparative advantage of production based on resource endowments of countries. Empirically, regional data on production only started to be exploited at the end of the nineteenth century, when the US Census published the first records on the topic.[5]

Traditionally, localization is measured with inequality indicators such as Theil, Entropy or Gini Localization indexes, showing how industrial employment is unequally spread across regions (individuals). The general consensus is that expanding industries tend to spread while declining industries tend to concentrate in particular areas (Dumais et al. [2002]). Thus, during the 20$^{\text{th}}$ century manufacturing was spreading and agriculture remained concentrated over the whole period Kim [1995], Krugman [1991, 2009]. Regarding aggregate services, the pattern over the last century seems unchanged and spread in proportion to population. However, in the last decades the growth of the service economy has led to the agglomeration of certain service sectors above the level of aggregate manufacturing industries. Ciarli et al. [2012] argue that the key to the agglomeration of services is how knowledge intensive they are. They define Knowledge Intensive Business Services (KIBS) as those services commonly provided to intermediate demand (consultancy, research, marketing). During the 20$^{\text{th}}$ century, knowledge intensive employees were relatively spread across states, but at the end of the period the sector concentrated in highly urbanized counties. Desmet and Fafchamps [2004, 2006] explained that the agglomeration of services took place in the biggest urban areas. Particularly, big cities such as New York, Chicago or San Francisco show a very high ratio for KIBS during the whole period.

In the last few decades, economic historians have pointed out that the relative importance of the service industry has increased through the last century in most developed economies. Carter et al. [2006] show that the allocation of employees across sectors changed radically in this period: initially service employment became the most important share of the economy to the detriment of agriculture initially and manufacturing from 1970. Hence, during the last century, the aggre-

[5] According to the US Census decennial records, the first geographical reference on production is presented in 1880 and describes cotton and cereal production by county.

gate economy of the United States specialized in the production of services, although not all counties behaved homogeneously: production and industrial structure of counties varied over time and, even more essentially, migrations varied cross-county population growth moving workers towards metropolitan areas.

The local agglomeration of knowledge intensive firms suggests that externalities explain these dynamics better than factor endowments: growth of KIBS may only happen in areas where demand (businesses) is guaranteed even if low transaction and transportation costs reduce distance by allowing companies in New York State to provide services to customers in Nevada at a similar cost than to local customers, (Meliciani and Savona [2014]).

However, externalities are far more complex than a pure demand effect. Marshall [1898] and Jacobs [1970] explained that closeness to the market implied inter and intra-industry linkages, a greater pool of labor, and knowledge spillovers, all of them leading to a lower cost of production. Other models explain agglomeration economies in terms of information costs: a high concentration of professional services (lawyers, judges, insurance firms...) reduces asymmetries of information and facilitates transactions [Fujita and Thisse, 2013, ch.6].

Furthermore, traditional services were characterized by being produced and consumed simultaneously, which made them uninteresting from the academic point of view because the chances of being geographically dispersed in proportion to population were high. More recently, technology has allowed knowledge intensive services to become storable, thus marginal costs of KIBS are smaller and allow producing a service in distant locations. These characteristics allow agglomeration economies to compensate for the greater costs of being in a crowded market (higher rents, greater competition).

The debate on the causes of localization is split into two main theories: the traditional argument is focused on natural endowments, while a more modern approach that defends market size as a cause of localization. The traditional endowments view (HO) holds that producers allocate close to their input resources. The main rationale is that resource availability determines the relative cost of production and comparative advantage and therefore, producers in a region will choose the bundle of products they can produce at a lower cost. This traditional argument is referred to as Rybczynsky's theorem and has been defended by Kim [1999] and

Ellison and Glaeser [1999] using manufacturing data for the USA for 19th and 20th centuries. Nevertheless, these authors acknowledge the several limitations of their approach including the broad scope of their analysis and the over-specification of their regression model.

Krugman [1991]'s seminal work criticized the traditional view by pointing out that the assumptions upon which classical trade theory relied were too restrictive. His work proposes a view based on Increasing Returns to Scale (IRS) that can be justified whenever marginal costs are relatively low, which evidences that classical assumptions are unrealistic in modern manufacturing industries (let alone in the knowledge intensive service economy). This view shows that industrial localization is more related to demand than supply: i.e., distance to factors of production becomes less of a restriction with lower transportation costs. However, being close to potential clients is crucial in a context of increasing returns to scale because low marginal costs lead to higher than proportional profits from increases in demand. This argument defends that being close to big markets is relatively more important than being close to fixed factors of production for modern manufacturing industries and decreasing transport costs. Scholars such as Amiti [2005] propose different production functions across sectors, leading to diverging configurations of the importance between IRS and factor endowments.

In the last decades, researchers have agreed upon the use of a mixed model, where relative importance of supply and demand arguments could vary across industries. In fact, even Kim [1999], who strongly supports the traditional HO view, admits that endowments explain the cross-section variation but that its explanatory power declines over time; he finally accepts that scale determines a lot of the time variation.

In this context, the general approach in determining the causes of localization involves testing the significance of coefficients in a model including both resource endowments and scale variables. Using this framework, authors have reached mixed conclusions based on different specifications. Commonly, the choice of the model tends to bias results. One of the key issues towards this bias is the unit of analysis, which tends to be too big and overlooks the local nature of IRS. In this sense, the database presented here captures both effects by using counties instead of nations, regions or states. I consider a model based on the framework used by

Davis and Weinstein [2003] or Rosés [2003], who explain industrial production based on endowments and market potential. To avoid these complications, the many dimensions of the data used in this analysis should be carefully studied prior to the statistical treatment of data.

4.3 Methodology and data

In this research I test how relevant endowments and scale effects are in determining the distribution of service employment across counties. Because services have not been studied in depth, this analysis is performed in steps to provide a complete view comparable to the trends in manufacturing. The main idea is to test how the presence of factor endowments affects the localization of services by county and then whether (and how) technology has changed the way these factors interact by looking at factor intensity in the production function as done by Kim [1999]. The analysis ends by testing how each county's market size affects the allocation of employees. Ultimately, this investigation analyses the mixed model on the disproportion of employment by county over the 20th century.

Employment data come from several sources from the US Census records: several editions of the Census of Population and Housing (15th, 17th and 20th) and County Business Patterns (2010); these provide data by industry and county for four benchmark years (1930, 1950, 1980 and 2010), yielding a total of nine industries and 3,189 counties.[6] Given the heterogeneity of the different censuses and the CBP, building the database implied the homogenization of the data to be comparable across industries and years. This homogenization process was performed from the most detailed general classification (1980) record to the least one (1930), so that industrial categories where the most accurate but correctly classified possible.

[6]Agriculture, Forestry and fisheries, Mining and Quarrying, Construction, Manufacturing, Utilities (Transportation and Warehousing, Telecommunications, Utilities and sanitary services), Trade (Wholesale, Retail), Personal services (Repair Services, Private household employees, Hotels and lodging places, Entertainment and recreation, Health, Education, Social services and organizations, Finance, insurance and real estate) and Knowledge Intensive Business Services (Business Services, Legal, engineering and others).

This methodology is built upon the models developed in successful papers exploring manufacturing. First, geographical inequality is measured by an approach similar to the one used by Krugman [1991] and Kim [1995]. However, the geographical unit at which data are gathered constitutes a key difference with respect to the available literature. In general, advocates of the HO framework have studied industry agglomeration of employees by state or broader geographical units (Kim [1995]; Kim and Margo [2003]). They also presented results by state or region, while Davis and Weinstein [2003] chose countries as the geographical unit of analysis. The choice of broad geographical scales may be a possible explanation of their results, as they ignore the subtle effect of external economies that occur at a local level.[7] Scholars have also used smaller geographical units like cities or urban areas (Glaeser et al. [1995]). However, according to Desmet and Fafchamps [2006] (p.2), this choice may lead to biased results based on a non-random selection of data that neglects the lower tail of the distribution (rural areas).

Acknowledging this possible bias, authors like Ellison and Glaeser [1999] and Kim and Margo [2003] have found results to differ when scale is changed. Foreseeing that determinants of local localization may not coincide with determinants of national patterns Ciccone and Hall [1996] developed a model using information aggregated at two geographical levels to explain differences in productivity.[8] Not surprisingly, the small number of studies based on county data managed to find evidence of IRS (Desmet and Fafchamps [2004, 2006]). Under the premise that IRS tend to be overlooked if the unit of study is too broad, the main geographical unit in this analysis is the county, however state boundaries and urban areas are also considered in the empirical analysis to check the robustness of the results. In this context, it is essential to emphasize the choice of counties over states or regions and the consequent reduction in the number of sectors in this research.[9]

[7]Krugman [1991] also presented results using data by state, however, the level of sectors within manufacturing was so detailed that he managed to find IRS evidence by state. This represents the trade-off between being detailed at a geographical level or at an industrial level.

[8]As Marshall [1898] put it: "Economies of massive production are of many different kinds: some are cosmopolitan property, some are national, some are local, and some belong to individual firms: each of these different kinds has its own method of affecting both the national and social issues in question".

[9]Note that inputting data by county in the spreadsheet grants the classification by state at almost no cost. In fact, regions, divisions and SMSAs are also used to control for institutional, geographical or other effects that might affect counties' production.

As mentioned, this preference responds to the principle that IRS have been overlooked when the unit of study was too big. However, a cost comes attached to such a decision: the sample size increases from 52 to 3,139 observations per industrial group and the dataset becomes somewhat less manageable.

The trade-off between the industrial classification detail and geographical unit of analysis has been resolved in favor of the geographical scale for two reasons. First, the previous methodologies have failed to find IRS at great scales, consistent with the hypothesis that IRS are originated locally. Moreover, the aggregate use of sectors allows greater detail in the geographical unit dimension that should not be wasted when there is such a gap in the economic history literature.

The final longitudinal database comprises an industrial classification grouped by sector (primary, secondary, tertiary). Further to this aggregate classification, data on Personal Services and Knowledge Intensive Business Services, which are the ultimate interest of this investigation, are also presented. This classification provides both decent visibility of the service sector that can be contrasted with the rest of the economy and greater geographical detail that will surely grasp the potential effect of IRS.

4.3.1 Location coefficients

Employment data have not been used in raw terms. Instead, these have been used to compute a coefficient to measure how disproportional is the distribution geographically. Hoover's Index of Localization or the Location Coefficient measures the disproportion in the allocation of employees of a specific sector i in a county j at period t with respect to the national share. This magnitude is represented by each of the points that create the Lorenz curve.[10] A geographically proportional industry will lead to observations of HLI's very close to 1 showing that each county has a similar proportion of employment in the sector to the national average. A

[10]Location coefficients are derived as

$$HLI_{ij} = LC_{ij} = \frac{\frac{E_{ji}}{E_i}}{\frac{E_j}{E}} \tag{4.1}$$

where E is total employment, i accounts for industry and j for region.

very localized industry will lead to a broader range of observations, where most counties will show a negative disproportion (between 0 and 0.9) and some will be greater than 1 (up to infinity) showing a greater than proportional allocation of sector *i*'s employment in the county.

Location coefficients by sector and county are the dependent variable of this analysis as opposed to the use of raw employment data. The main reason to use these coefficients as a dependent variable is that they are already adjusted for the population size of each county, measuring a disproportion on the allocation of employment with respect to national averages. This avoids biased results by tackling the effect of bigger population clusters that have more service employment.

4.3.2 Factor endowments

A way to account for the effect of factor endowments is usually to look at the availability of resources in each region. The literature treats this in different ways: from relative shares of factors, to instrumental variables that control for agricultural productivity (Kim [1999]). In this study, the choice is limited to the use of relative factor endowment shares by state to represent the HO variables. In this framework, factors are arable land, capital and several kinds of labor (unskilled, agrarian, clerical and professional). These variables have been calculated as the state's share of each factor with respect to the national economy.

The data on arable land come from the US Department of Agriculture that provides data on millions of acres of arable land per state. Data on capital stock are difficult to find, but these are proxied by the estimations on net private capital stock provided by Garofalo and Yamarik [2002] who provide them from 1940s onwards and were calculated based on national trends for 1930. The records of relative shares of labor per state were obtained from the US Census and transformed into shares relative to the national total accordingly.

4.3.3 County Market Potential

The original definition of market potential was proposed by Harris [1954] as an indicator of a location's accessibility to other markets formulated as the sum of the rest of the regions' size (measured by GDP) and weighed by bilateral transport costs or distances. This investigation aims to find increasing returns at county level and, therefore, an indicator of state MP might not be detailed enough to grasp the local effect of spillovers. Under this premise, the data of market potential is much more exhaustive than the data on factor endowments as current research has proved that aggregate data on resources are powerful enough to explain industrial agglomeration.

The observations of MP have been calculated following Crafts and Mulatu [2005] and Martínez-Galarraga [2012], who use the traditional definition of MP as the sum of the size of potential markets measured by GDP weighed by the bilateral economic distances:

$$MP_i = \sum_{(j-1)}^{(j-n)} \frac{M_j}{d_i j} \tag{4.2}$$

Economic distance is the distance between pairs weighted by transportation costs. These have been estimated based on Jacks et al. [2008], Mohammed and Williamson [2004] and Harris [1954] data and are shown in Table 12 in the Appendix. Total MP is further decomposable by the domestic and foreign effect:

$$MP_i = DMP_i + FMP_i \tag{4.3}$$

$$MP_i = \sum_{(j-i)}^{(1,n)} \frac{M_s}{d_i, s} + \sum_{(US-i)}^{(1,n)} \frac{M_U S}{d_i, US} + SP_i + FMP_i \tag{4.4}$$

In this dataset, counties' MP has been decomposed into its Domestic Market Potential and Foreign Market Potential. Furthermore, the domestic element can be further disentangled into the nation's, the state neighboring counties and *i*'s own self-potential. Following Crafts and Mulatu [2005] and Martínez-Galarraga [2012], the self-potential component has been calculated as the county's size measured by GDP, divided by the radius of the circle with an equivalent area of the county to control for distance:

$$MP_i = \sum_{(j-i)}^{(1,n)} \frac{M_s}{d_i, s} + \sum_{(US-i)}^{(1,n)} \frac{M_U S}{d_i, US} + \frac{\frac{E_i}{E_s}(Ms)}{(1/3)\sqrt{\frac{area_c}{\pi}}} + \sum_{(j-i)}^{(1,n)} \frac{M_F}{d_i, F} \cdot d_c, F^{-0.8} \cdot coast_c \tag{4.5}$$

The formulation used to calculate MP has been simplified to adjust to data availability by assuming free trade and approximating the size of each county through the share of state employment, leading to Real Self-Market Potential as in Combes et al. [2008], (ch. 12). However, it has been taken into account that trade is easier from bigger cities than from remote counties, adjusting for the distance between the domestic nodes needed to transport exports out of the county. Similarly, coastal regions have been favored over inland regions as the traditional formulation shows in equation (5).[11]

One of the main issues raised from this calculation is that most of the MP effect is coming from the foreign market even when focusing on small areas such as counties. Table 4.1 shows the average level of Market Potential and its different components in each benchmark year and its growth rates by decade. The table shows that Market Potential has been increasing consistently through time: decreasing transport costs, openness to trade and economic growth (greater size of economies measured by its GDP) of countries have driven this. County Self-potential represents a small share of the TMP composition for counties, thus, most of the domestic effect is related to the national market. However foreign demand coming from other counties represents the greatest component of MP and its share is increasing over time.

Table 4.1: Average Market Potential for US counties

	Level				% Growth rate		
Component	**1930**	**1950**	**1980**	**2010**	**30-50**	**50-80**	**80-10**
Foreign MP	80.66	50.80	73.59	87.58	33.44	89.98	82.2
Domestic MP	19.34	49.20	26.41	12.42	83.52	72.97	55.14
Nation	14.59	34.36	19.32	9.12	82.21	74.18	55.33
State	3.11	11.64	5.41	2.49	88.82	68.81	54.16
Self-Potential	1.65	3.20	1.68	0.81	78.39	72.37	55.99
TOTAL	100	100	100	100	58.08	85.49	78.90

Calculations based on 32 trade partners with complete data availability for all benchmark years expressed in 10^3. *Source: own author's calculations go to Appendix F for more information.*

Market Potential estimations show that overall TMP has increased through the century, although growth has slowed down in recent decades for all components. The trends of County Foreign MP reveal the US as one of the main world exporters in the world since the inter-war period and the decrease in recent decades shows

[11] More information regarding this point is developed in the appendix.

the upswing of other regions as world producers (Asia). Individual MP county analysis shows that inland counties have on average lower market potential than coastal counties, although lower transportation costs have allowed a relative catch up of inland counties' Market Potential over the century.

This section has explained the sources and shape of Hoover's locational coefficients by sector as the dependent variable of this paper and the factor endowments shares and Market Potential calculations as explanatory variables in the mixed model of localization. Although there are more details in the Appendix, this provides a good context in which to approach the regression analysis of the localization model.

4.4 Empirical analysis

4.4.1 Step 1: How important are factor endowments for each sector?

This first stage of the analysis replicates the model of those who defend the HO view, but it is also a step taken by defenders of the mixed model as a preliminary analysis of the impact of factor endowments on agglomeration (Ellison and Glaeser [1999]; Missiaia [2014]; Rosés [2003]). The main idea is to assess the significant impact of endowments on the disproportion in the allocation of sectorial employment without considering other regressors in the following equation:

$$HLI_{ijt} = \alpha_{it} + \beta_1 f_{it}(N, HL, K) + e_{it} \tag{4.6}$$

The interest of this exercise lies in ensuring that factor endowments are significant for determining location. Table 4.2 shows that indeed factor endowments are statistically significant to the disproportional allocation of employment in different sectors, however my initial hypothesis leads me to suspect the presence of possible omitted variable bias in the estimators.[12] Under this simple OLS framework, the size and direction of the estimators of resource availability is misleading. While the effect of Land abundance is significantly large and positive on the localization

[12]Market Potential is contained in the error term and, if significant, these estimators must be biased.

of primary sector employees and negative for any other sector, the effect of mobile factors of production (Capital Stock and Skilled and Unskilled labor) seems mixed across sectors. Including interaction terms on the availability of different resources seems to yield more intuitive results in Table 4.3.

The table presents the coefficients of both single factors and interactions between factors that are used more intensively in each sector (i.e. those that allow comparative advantage) building on the work of Kim [1999]. In this case, interaction terms between Land and Agrarian workers show a much higher effect than the single factors on counties location coefficients for the primary sector.

Table 4.2: OLS Heckscher-Ohlin determinants of employment localization, pooled sample

Variable	Primary	Secondary	Tertiary	Personal	KIBS
Land	35.309***	-4.019***	-2.300***	-1.463***	-1.857***
	(1.102)	*(0.196)*	*(0.116)*	*(0.125)*	*(0.143)*
Artisans	-111.7277***	8.375***	9.613***	5.624***	3.334***
	(7.672)	*(1.397)*	*(0.778)*	*(0.881)*	*(1.030)*
Professionals	23.830***	-5.152***	-1.982**	4.779***	4.929***
	(6.711)	*(1.463)*	*(0.838)*	*(0.807)*	*(0.837)*
Clerical	41.399***	-5.063***	-3.772***	-0.977***	0.566
	(2.611)	*(0.599)*	*(0.329)*	*(0.337)*	*(0.536)*
Agrarian	-1.115***	-0.075	0.011	-0.073	-0.289***
	(0.524)	*(0.145)*	*(0.073)*	*(0.073)*	*(0.091)*
Capital Stock	3.205	-0.878	-1.404***	-1.188***	2.202***
	(2.676)	*(0.599)*	*(0.251)*	*(0.359)*	*(0.339)*
Unskilled	18.489	6.509***	-0.294	-6.783***	-8.569***
	(5.935)	*(1.555)*	*(0.861)*	*(0.842)*	*(0.998)*
1950dummy	0.525	0.059***	0.003		-0.264***
	(0.040)	*(0.159)*	*(0.007)*		*(0.009)*
1980dummy	0.928	0.294***	0.191***	0.039***	-0.307***
	(0.052)	*(0.016)*	*(0.009)*	*(0.007)*	*(0.009)*
2010dummy	3.125	0.521***	-0.059***	-0.034***	-0.401***
	(0.083)	*(0.019)*	*(0.007)*	*(0.007)*	*(0.008)*
Constant	1.869***	0.593***	0.786***	0.835***	0.842***
	(0.038)	*(0.018)*	*(0.007)*	*(0.008)*	*(0.008)*
r-squared	0.28	0.18	0.14	0.11	0.16
N	11937	11441	11953	8976	11896

Dependent variable: Location coefficient by county. Independent variables: proportion of factor endowments by state. Coefficients from OLS Regression for pooled observations in 1930, 1950, 1980 and 2010 (data for personal services for 1930 unavailable). Standard Errors robust to heteroskedasticity in brackets under the coefficients, where (*), (**) and (***) correspond to significantly different from zero coefficients at 10%, 5% and 1% confidence level. *Source: own calculations.*

The sum of the single coefficients of the variables Land and Agrarian is smaller than the significance of their interaction term. Available arable land is not enough to produce agricultural products; there is a need for skilled labor to work this land. The effect of Land is always significant, but the effect of Agrarian is mixed (probably too small). Conversely, the interaction of Unskilled with Agrarian is not significant, probably because the effect of having a great amount of Unskilled workers does not allow a proper environment for agricultural production, and having a great mass of unskilled labor might be more relevant for manufacturing and services. Note that Table 4.3 only reports the model specifications where coefficients are significant.

The previous results show evidence in favor of the Rybzcynski theorem: counties abundant in a factor tend to specialize in production of industries intensive in that factor (Kim [1999]). In other words, industries concentrate where their intensive factor is abundant. Note, however, that both the size of coefficients and the explanatory power of the regression are much higher for the primary sector suggesting that relative factor abundance might help explain agricultural allocation better than other sectors. Another reason behind the poor fit of this regression is that the pooling of data neglects the evolution of production functions through time and because different levels of disproportion might also be correlated across time and space. For that matter, a regression that considers time and space fixed effects would be more useful.

Considering the possible effect that regions and time could have on the disproportional allocation of employees by sector, Table 4.4 shows estimates of OLS with region fixed effects, time fixed effects and GLS random effects in case there is dependence in the error term of the explanatory variables.[13]

[13] In order to avoid imposing a particular shape on the distribution of the error term, it was decided to perform a simple regression with clustered errors at several levels (County, State, Division and Region). These regressions yield the same coefficients than the GLS random effects estimation but much higher standard errors. It was found that significance of coefficients changed when the clustering was performed by any other level that was not the county dropping significance at higher levels of aggregation. The exception was the regression for KIBS where results seemed robust to any clustering level.

Table 4.3: OLS Heckscher-Ohlin determinants of employment localization with interaction terms, pooled sample

Variable	Primary	Secondary	Tertiary	Personal	KIBS
Land		-4.020***	-2.191***	-1.299***	-1.768***
		(0.195)	*(0.109)*	*(0.116)*	*(0.129)*
Agrarian		-0.148**	-0.064		
		(0.148)	*(0.084)*		
Land*agrarian	273.217***				
	(12.881)				
Artisans	-19.206***	5.268***	5.260***	5.039***	6.649***
	(6.812)	*(1.472)*	*(0.655)*	*(0.626)*	*(0.748)*
Unskilled	-11.806***	6.596	1.315*	-4.335***	-6.123***
	(6.495)	*(1.674)*	*(0.815)*	*(0.665)*	*(0.789)*
Professionals	-30.957***	-5.235***	-1.691		
	(5.938)	*(1.47)*	*(0.839)*		
Clerical	24.662***	-1.169			
	(2.681)	*(1.081)*			
Capital Stock	3.741				
	(2.775)				
Capstock*Unskilled		42.026**			
		(24.823)			
Capstock*Professional			-11.209	24.513***	33.455***
			(7.475)	*(4.900)*	*(7.557)*
Capstock*Clerical		-50.362	-16.235***	-36.458***	-36.467***
		(18.204)	*(5.375)*	*(6.455)*	*(7.026)*
Clerical*Professional				19.381***	15.903***
				(3.544)	*(4.601)*
1950dummy	0.514***	0.058***	0.005		-0.240***
	(0.039)	*(0.015)*	*(0.006)*		*(0.009)*
1980dummy	0.913***	0.292***	0.191***	0.037***	-0.290***
	(0.055)	*(0.015)*	*(0.007)*	*(0.007)*	*(0.008)*
2010dummy	3.115***	0.519****	-0.059***	-0.042***	-0.382***
	(0.085)	*(0.019)*	*(0.006)*	*(0.007)*	*(0.008)*
Constant	2.602***	0.572***	0.748***	0.841***	0.832***
	(0.031)	*(0.020)*	*(0.008)*	*(0.008)*	*(0.008)*
r-squared	0.220	0.182	0.147	0.05	0.160
N	11937	11441	11953	9288	12314

Dependent variable: Location coefficient by county. Independent variables: proportion of factor endowments by state. Coefficients from OLS Regression for pooled observations in 1930, 1950, 1980 and 2010 (data for personal services in 1930 unavailable). Standard Errors robust to heteroskedasticity in brackets under the coefficients, where (*), (**) and (***) correspond to significantly different from zero coefficients at 10%, 5% and 1% confidence level. *Source: own calculations.*

Factor coefficients still seem more relevant for the primary sector, where the sign and significance of coefficients is robust to any of the specifications presented. The sign of significant coefficients is behaving close to expectations in all the sectors, except Capital Stock and its interaction terms for the tertiary sector. A possible reason for this result is the heterogeneity of the tertiary sector that contains very different production functions where Capital Stock and different kinds of labor may interact very differently (Section 4.2 and Table 4.7 illustrate this point better).

The OLS estimation was tested against the region fixed effects specification by conducting the Hausman test, where the null hypothesis was always rejected. Additionally, Breusch-Pagan Lagrange-Multiplier tests permitted the sound rejection of the Random Effects estimation in all sectors. This was not surprising because the Random Effects model's assumptions require the error term to be uncorrelated with the independent variables. Because Market Potential is contained in the error term in this specification, the coefficients must necessarily be biased and correlated with the error.

With all the evidence pointing at a fixed effects model where region effects appear significant for the three sectors, the Hausman test also shows some evidence in favor of the two-way fixed effect specification. Yearly dummies were jointly statistically different than zero and also individually significant. As a result, the two-way fixed effects model seems the most appropriate specification to determine the HO effect in the disproportional allocation of employees across counties for all the sectors. Note that this is also the model that better fits the data according to the R-squared.

These results hold not only for aggregate sectors, but also for service subsectors shown in Table 4.5, where the two-way fixed effects model shows that Land abundance prevents a greater than proportional allocation of services (it does not allow the benefits of spillovers), while the joint abundance of Capital Stock and Professional workers allow this disproportion in services with significant coefficients.

Table 4.4: Heckscher-Ohlin determinants of regional production with interactions, fixed and random effects using a pooled sample

Variable	**Primary Sector**			**Secondary Sector**			**Tertiary Sector**		
Land				-3.840***	-3.949***	-4.300***	-1.925***	-1.886**	-2.191***
				(0.203)	*(0.594)*	*(0.193)*	*(0.119)*	*(0.355)*	*(0.115)*
Agrarian				-0.050	0.050	-0.351***	-0.010	0.091	-0.094
				(0.136)	*(0.199)*	*(0.124)*	*(0.089)*	*(0.288)*	*(0.086)*
Land*agrarian	203.635***	250.836***	231.292***						
	(16.742)	*(15.909)*	*(16.461)*						
Artisans	-16.137**	-5.820	-26.924**	9.940***	9.765***	11.216***	4.510***	4.279**	4.927***
	(7.335)	*(41.841)*	*(7.138)*	*(1.334)*	*(1.281)*	*(1.281)*	*(0.684)*	*(0.928)*	*(0.644)*
Unskilled	-47.572***	-37.097	-23.060***				0.667	1.197	-0.061
	(8.631)	*(64.306)*	*(8.189)*				*(0.767)*	*(1.886)*	*(0.700)*
Professionals	-23.984***	-23.869	-32.437***	-1.222	-0.363	-1.833			
	(6.744)	*(73.763)*	*(6.444)*	*(1.248)*	*(1.145)*	*(1.205)*			
Clerical	26.740***	27.815	22.437***	-6.486***	-4.653**	-6.636***			
	(3.464)	*(18.631)*	*(3.455)*	*(0.722)*	*(1.429)*	*(0.721)*			
Capital Stock	37.727***	7.103	34.227***						
	(2.454)	*(20.206)*	*(2.4612)*						
Capstock*Unskilled				7.559	-25.196	13.444**			
				(5.725)	*(29.013)*	*(5.392)*			
Capstock*Professional							-9.594	-22.860	-3.880
							(8.616)	*(33.079)*	*(8.546)*
Capstock*Clerical							-22.721***	-15.124	-20.829***
							(6.037)	*(19.743)*	*(6.030)*
Constant	3.709***	2.615***	3.732***	0.860***	0.598***	0.859***	0.779***	0.736***	0.789***
	(0.045)	*(0.220)*	*(0.042)*	*(0.010)*	*(0.087)*	*(0.010)*	*(0.007)*	*(0.084)*	*(0.006)*
r-squared	0.06	0.21	0.08	0.03	0.17	0.05	0.05	0.14	0.06
N	11937	11937	11937	11441	11441	11441	11953	11953	11953
Region fixed effects	yes	yes	no	yes	yes	no	yes	yes	no
Year fixed effects	no	yes	no	no	yes	no	no	yes	no
Random effects	no	no	yes	no	no	yes	no	no	yes

Dependent variable: Location coefficient by county. Independent variables: proportion of factor endowments by state. Coefficients from OLS Regression for pooled observations in 1930, 1950, 1980 and 2010 with one and two-way fixed effects and GLS Random effects. Standard Errors in brackets under the coefficients, where (*), (**) and (***) correspond to significantly different from zero coefficients at 10%, 5% and 1% confidence level. *Source: own calculations.*

Interestingly, one could question what the causal direction of this effect is: i.e. is the disproportion in the allocation of services created by a high share of this kind of mobile factor or is the availability of this factor causing the geographical disproportion in the sector? This question will be addressed again in section 4.4.4, as the current equation is aimed to simply test the significance of availability of resources on the disproportional allocation of workers.

Lastly, note that the interaction between Clerical workers and Capital Stock has a negative coefficient in both personal and knowledge intensive services. This could be because the lower dynamism that a local market where clerical workers are present in a more than proportionate share (where bureaucracy might be high) leads to less benefit of knowledge spillovers, where the true positive effect goes from professional workers benefiting from the assistance of clerical labor and capital stock (knowledge hubs).

4.4.2 Step 2: How has technology shaped the production function of services?

After confirming that indeed factors of production matter when determining the geographical distribution of sectors, economic historians might be interested in the changes in production functions across time.

$$HLI_i = \alpha_i + \beta_1 f_i(N, HL, K) + e_i \tag{4.7}$$

In Kim [1999] the author accounts for changes in the production function of manufacturing by looking at the factor intensities of the production of manufacturing sectors over time. Because the service economy has changed from producing mostly personal services to a more dynamic system where, obviously, technology has defined the way workers interact with other factors -see Broadberry and Ghosal [2002]- it is necessary to assess the changes that production functions might have experienced.

Table 4.5: Heckscher-Ohlin determinants of production for service sub-sectors with interaction terms, fixed and random effects

Variable	**Personal Services**			**KIBS**		
Land	-1.001***	-1.021**	-1.280***	-1.422***	-1.690***	-1.528***
	(0.119)	(0.220)	(0.116)	(0.146)	(0.078)	(0.142)
Artisans	5.601***	5.557	5.096***	9.217***	9.509**	6.457***
	(0.666)	(2.419)	(0.630)	(0.837)	(1.701)	(0.790)
Unskilled	-4.201***	-4.165	-4.393***	-7.293***	-8.200**	-5.439***
	(0.753)	(2.140)	(0.679)	(0.947)	(1.746)	(0.853)
Capitalstock*professional	21.152***	20.081*	24.741***	10.649	27.206**	18.609**
	(6.328)	(7.705)	(5.499)	(8.519)	(6.350)	(7.394)
Clerical*professional	14.547***	12.890	21.074***	37.120***	6.238	47.899***
	(3.937)	(7.787)	(3.819)	(4.439)	(8.165)	(4.176)
Clerical*capitalstock	-38.008***	-36.895*	-38.686***	-62.931***	-33.662**	-67.194***
	(7.057)	(15.496)	(6.565)	(8.679)	(8.780)	(7.758)
Constant	0.825***	0.828***	0.838***	0.582***	0.823***	0.593***
	(0.006)	(0.024)	(0.006)	(0.008)	(0.099)	(0.007)
r-squared	0.03	0.04	0.04	0.03	0.15	0.04
N	9288	9288	9288	12314	12314	12314
Region fixed effects	yes	yes	no	yes	yes	no
Year fixed effects	no	yes	no	no	yes	no
Random effects	no	no	yes	no	no	yes

Dependent variable: Location Coefficient by county. Independent variables: proportion of factor endowments by state. Coefficients from OLS Regression with one and two-way fixed effects and GLS Random effects for years 1950, 1980 and 2010. Standard Errors in brackets under the coefficients, where (*), (**) and (***) correspond to significantly different from zero coefficients at 10%, 5% and 1% confidence level. *Source: own calculations.*

The following tables show changes in factor intensities in the production of service sub-sectors by year. The outcome suggests that production functions of services have changed over the century. For example, the effect of Capital Stock on the localization of knowledge intensive sectors is greater in 1930 than in 1980. In 2010, the effect of capital is only relevant through its interaction with high-skilled workers. These variations on the relative importance of each factor on the localization index hold for any sub-sector in the regression. Additionally, note that the fit of the regressions improve substantially by performing yearly regressions instead of pooled OLS regressions.

Table 4.6: Heckscher-Ohlin determinants for service employment localization by year

Variable	**1930**	**1950**	**1980**	**2010**
Land	-1.025***	-0.105	-5.105***	-4.041***
	(0.217)	(0.188)	(0.358)	(0.257)
Capital stock	0.499	0.366	-2.050	6.988***
	(0.893)	(0.999)	(1.922)	(0.853)
Artisans	13.653***	6.297***	13.261***	1.399
	(1.238)	(1.328)	(2.595)	(1.451)
Professionals	9.104***	7.869***	-25.057***	-0.955
	(1.453)	(1.319)	(2.518)	(1.276)
Clerical	-4.376***	-1.661***	-9.002***	-2.001***
	(0.547)	(0.488)	(1.031)	(0.501)
Unskilled	-16.096***	-11.710***	25.719***	-1.587
	(1.627)	(1.656)	(2.455)	(1.238)
Agrarian	-0.654***	-0.377***	1.187***	-0.723***
	(0.127)	(0.108)	(0.262)	(0.137)
Constant	0.924***	0.879***	0.906***	0.872***
	(0.023)	(0.018)	(0.034)	(0.014)
r2-squared	0.24	0.15	0.35	0.16
N	2969	3006	2954	3024
Region-fixed effects	yes	yes	yes	yes

Dependent variable: Location Coefficient by county. Independent variables: proportion of factor endowments by state. Coefficients from OLS Regression with region fixed effects. Standard Errors in brackets under the coefficients, where (*), (**) and (***) correspond to significantly different from zero coefficients at 10%, 5% and 1% confidence level. *Source: own calculations.*

More specifically, Table 4.7 presents the regression results of yearly coefficients of aggregate services using the region fixed effects model consistent with the previous step. It appears that Capital Stock has become more intensively used over the years. It is also interesting how Land abundance seems to prevent the localization of services to a greater degree as time passes. However, the rest of the coefficients lead to mixed results; again, it is necessary to look at the service sector in more depth to avoid misleading conclusions derived from the heterogeneity of the sector.

The coefficients available in Table 4.7 suggest that Personal Services behave differently to KIBS, particularly from 1980 when the knowledge intensive sector suffered a great change in the production function. Specifically, note how the effect of Capital Stock is much higher for KIBS than for Personal services (particularly from the 1980s from the interaction of Capital Stock and Professional labor). The evolution of the Land and Agrarian labor coefficients is also noteworthy, when the negative effect it causes on the agglomeration of service employment seems increasing over time. This leads to the idea of a snowball effect, where the migration of skilled labor to more urbanized areas applies, as Moretti [2012] observes. Again, the effect of Clerical workers abundance is unclear across time. While the coefficient Unskilled workers is consistent with the definition of KIBS, negative and significant across all benchmark years. The effect of Unskilled labor is changing through time in the case of Personal services, probably because the employment of Unskilled workers is spread across sectors as they join the sector that is growing at each period of time (manufacturing before 1980, personal services later on).

4.4.3 Step 3: Does market potential affect the disproportion of employment?

Up to now, results are in favor of the relevance of factor endowments in the geographical distribution of employment and the difference of intensities across time. The last step of this analysis involves adding the variable of Market Potential to the model:

$$HLI_{ij} = \alpha_i + \beta_1 f_i(N, HL, K) + \beta_2 MarketPotential_i + e_i \tag{4.8}$$

This formulation of the industrial disproportion of employment (HLI) explains the localization in two components. The first element of the equation represents the function of the relative endowments of the county, the Heckscher-Ohlin effect, and the second part accounts for Market Potential (MP).

Including Market Potential in the model has three straightforward effects on results. First, Market Potential is relevant and significant for all sectors. MP correlates positively for all sectors except for the primary sector where it has a large negative effect. Second, when MP is added to the regression equation, most of the HO factors become insignificant and inconsistent with previous results. Lastly, it increases the fit of the regression.

Table 13 in the appendix presents the regressions of locational indexes of services using the complete model specification as explained in equation (7). These results are calculated using the two-way fixed effects regression that was proved the best possible specification in previous sections. However, random effects and pooled data have also been ruled out in this new model.[14] Profiting from the decomposability of TMP, this step can be used to capture where IRS originates by regressing the different elements of TMP in the same model. Results of the regression of Self-Potential and HO on the locational coefficient (in Table 14 also in the appendix) do not differ greatly with Total Market Potential. In fact, most of the resources remain insignificant while the coefficient of Self-Potential is still more extreme.

Table 4.8 shows the yearly coefficients with fixed effects for the service economy. The coefficients report the increasing importance of local market potential from decade to decade. The coefficient is twice as big for the knowledge intensive sector from 1980 onwards. This leads to the powerful conclusion that the scale effect is experienced at a local level more than at an international or national level. In other words, according to these results, Increasing Returns do affect the localization of employees, particularly those of the service economy who have gradually agglomerated where local demand was high.

[14]The Hausman test led to a rejection of the null hypothesis that OLS could be more efficient than the fixed effects estimation. Fixed time effects proved jointly significant through yearly dummies and Breusch-Pagan test soundly rejected the possibility of random effects.

Table 4.7: Services localization determinants by year

Variable	**Personal Services**			**KIBS**				
	1950	1980	2010	1950	1980	2010	1980	2010
Land	-0.577**	-1.898***	-3.924***	-0.141	-2.923***	-5.953***	-2.598***	-4.715***
	(0.226)	*(0.201)*	*(0.308)*	*(0.335)*	*(0.341)*	*(0.415)*	*(0.358)*	*(0.407)*
Agrarian	-0.306**	-0.803***	-0.566***	0.168	-1.181***	-1.217***	-1.159***	-0.698*
	(0.144)	*(0.148)*	*(0.173)*	*(0.212)*	*(0.250)*	*(0.233)*	*(0.419)*	*(0.405)*
Artisans	6.943***	2.188	-1.986	3.352	-9.115***	4.858**	10.091***	9.593***
	(1.682)	*(1.464)*	*(1.779)*	*(2.493)*	*(2.470)*	*(2.392)*	*(1.663)*	*(1.598)*
Unskilled	-10.397***	-8.616***	3.764**	-4.660	-13.904***	-6.141***	-12.946***	-2.459
	(1.985)	*(1.238)*	*(1.646)*	*(2.937)*	*(2.087)*	*(2.216)*	*(1.887)*	*(1.798)*
Clerical	-0.011	-1.422**	-0.846	0.957	7.820***	-3.643***		
	(0.693)	*(0.562)*	*(0.653)*	*(1.025)*	*(0.945)*	*(0.878)*		
Professionals	7.314***	3.537***	-4.629***	-3.114	5.778***	-1.172		
	(1.571)	*(1.068)*	*(1.433)*	*(2.318)*	*(1.807)*	*(1.928)*		
Capital Stock	-3.541***	7.910***	7.764***	2.726	13.207***	11.708***		
	(1.156)	*(1.068)*	*(1.032)*	*(1.715)*	*(1.803)*	*(1.389)*		
Capital*professional							51.718***	51.870***
							(13.028)	*(11.991)*
Clerical*capital							-14.572	-70.040***
							(10.999)	*(10.335)*
Constant	0.980***	0.997***	0.956***	0.586***	0.746***	0.573***	0.796***	0.533***
	(0.028)	*(0.020)*	*(0.026)*	*(0.042)*	*(0.033)*	*(0.034)*	*(0.034)*	*(0.034)*
r-squared	0.08	0.11	0.12	0.01	0.12	0.10	0.09	0.08
N	3006	2946	3024	2991	2926	3010	3029	3114

Dependent variable: Hoover's index of localization by county. Dependent variables: proportion of factor endowments by state. Coefficients from OLS Regression with one and two-way fixed effects and GLS Random effects. Standard Errors in brackets under the coefficients, where (*), (**) and (***) correspond to significantly different from zero coefficients at 10%, 5% and 1% confidence level. *Source: own calculations.*

Table 4.8: Determinants of HLI service sub-sectors by year

Variable	**Personal Services**			**KIBS**			
	1950	1980	2010	1930	1950	1980	2010
Land	0.697	-1.295***	-2.432***	-1.180	-0.496	-0.364***	-2.432***
	(0.507)	*(0.293)*	*(0.710)*	*(0.925)*	*(0.765)*	*(1.332)*	*(0.710)*
Artisans	2.347	2.819	4.727	12.249***	8.570	4.618	4.727
	(1.508)	*(1.610)*	*(2.708)*	*(2.618)*	*(3.857)*	*(4.252)*	*(2.708)*
Unskilled	-4.192**	1.281	-2.775	-8.455	-9.597	-14.585**	-2.775
	(2.296)	*(2.274)*	*(3.772)*	*(4.825)*	*(5.999)*	*(4.796)*	*(3.772)*
Capital*Professional	-19.222	-40.465*	-17.792	-69.946	98.200	91.182	-17.792
	(24.616)	*(20.222)*	*(26.548)*	*(102.252)*	*(69.898)*	*(85.885)*	*(26.548)*
Clerical*professional	43.494	-24.934	-67.871***	-36.922	-115.812**	26.484	-67.871
	(29.856)	*(18.894)*	*(20.111)*	*(19.837)*	*(47.646)*	*(25.145)*	*(20.111)*
Clerical*Capital	-18.765	-47.727	83.654	-9.387	54.447	-38.861	83.655
	(25.026)	*(37.110)*	*(43.740)*	*(49.891)*	*(29.991)*	*(53.699)*	*(43.739)*
log MP	0.028***	0.024***	0.040***	0.011***	-0.003	0.019***	0.040***
	(0.007)	*(0.004)*	*(0.003)*	*(0.003)*	*(0.007)*	*(0.004)*	*(0.0034)*
Constant	0.278***	0.162***	0.259***	-0.198***	0.577***	-0.291***	-0.475
	(0.149)	*(0.034)*	*(0.032)*	*(0.035)*	*(0.054)*	*(0.109)*	*(0.187)*
r-squared	0.028	0.065	0.048	0.145	0.008	0.044	0.048
N	3107	3043	3052	3132	3092	3023	3108

Dependent variable: Location coefficient by county. Dependent variables: proportion of factor endowments by state and County Local Market Potential. Coefficients from OLS Regression with one and two-way fixed effects and GLS Random effects. Standard Errors in brackets under the coefficients, where (*), (**) and (***) correspond to significantly different from zero coefficients at 10%, 5% and 1% confidence level. *Source: own calculations.*

The good news for NEG advocates leads to unsatisfactory results of the mixed model and indicate the necessity of a test of Market Potential as a single explanatory variable. The information presented in Table 4.9 shows the results of the single regression of locational coefficients on the logarithm of different components of Market Potential.

Table 4.9: OLS Market Potential effect in localization, pooled data

Variable	**Primary**	**Secondary**	**Tertiary**	**Personal**	**KIBS**
Log Total MP	-0.396***	0.037**	0.025***	0.032***	0.026***
r-squared	*0.24*	*0.15*	*0.09*	*0.04*	*0.15*
Log Foreign MP	-0.289***	0.031**	0.017***	0.022***	0.023***
r-squared	*0.25*	*0.15*	*0.10*	*0.05*	*0.15*
Log Self-Potential	-1.169***	0.086***	0.090***	0.079***	0.120***
r-squared	*0.46*	*0.17*	*0.21*	*0.16*	*0.28*

Dependent variable: Hoover's index of localization by county. Independent variables: Logarithm of Market Potential by county (Foreign, Domestic, SP). Coefficients from two-way fixed effects regression from pooled data for 1930, 1950, 1980 and 2010 where (*), (**) and (***) correspond to significantly different from zero coefficients at 10%, 5% and 1% confidence level. R-squared of the simple regression reported under the coefficient. *Source: own calculations.*

One might regard the effect of market potential on localization as relatively small, however its marginal effect is quite high in comparison to other variables: the marginal effect of Log Total MP at means for the two way fixed effects model is equal to 0.117 in the localization index of KIBS, while the marginal effect at means of land represents a value of -0.603 (from Table 13). These coefficients provide evidence in favor of Increasing Returns as the explanation of not only services and manufacturing but also agriculture, where Market Potential has always been left off the table. In this case, it seems that regions where Self-Potential is high prevent the localization of agricultural industries. In other words, Agriculture cannot be produced close to urban areas. In this context one may question the possible simultaneous causality problem in this model specification, as it is clear that agricultural production must have been established in certain areas prior to urbanization. The trials with random effects specifications have reported very high Lagrange-Multiplier coefficient, which rules out the Random Effects specification in favor of Fixed Effects. This time, the error term could be assumed independent to the variables included in the model, however further checks are required to solve these doubts.

4.4.4 Testing for endogeneity

Up to this point, the text has focused on the use of variables dependent on mobile factors of production. However, there remains the problem that Market Potential could be simultaneously determined in the model.

For starters, the simple calculation of Total Market Potential implies that at least the local component of market potential is completely dependent on the size of the region measured by GDP. Furthermore, Self-Potential is determined by the relative factor prices of resource endowments of each allocation. These factor prices are in turn dependent on the number of people in the county. A high Locational Coefficient of KIBS will lead to higher wages for Skilled workers, resulting in the migration of skilled workers to the county. All in all, finding an instrument that accords with Combes et al. [2008] could be a solution to the potential bias caused by the simultaneous causation problem.

As we have seen, panel data allow for the isolation of year specific and also region specific factors that could affect both locational coefficients and factor prices, but the interaction between the agglomeration of workers and both Market Potential and Factors can only be isolated through the use of instrumental variables. The instruments chosen in this context include the lag of mobile resource endowments (the allocation of resources of 1930 to determine the localization patterns of 1950 and so on). I considered using the lag of Market Potential in a similar fashion, however, since Redding and Venables [2004] find that the Foreign element of Total Market Potential is completely exogenous, it was used as an instrument for Total Market Potential. [15] The complete IV regression was performed in the Generalized Method of Moments because it allows clustering the standard errors by region. The first experiment involved the test of all the variables in the model. The results from this regression show that both resource endowments and market potential are significant across counties, leading to some hope for the use of the mixed model. Complete regression results can be found in the appendix, Table 15. However, further tests of endogeneity on the instrumented variables lead to the invalidation of these results because the Hausman test was not significant for any of the instrumented mobile factor endowments. Based on this result and the

[15] Combes et al. suggest the use of a natural disaster as an instrument for Market Potential. The famous 1974 Tornado Outbreak was used but it did not yield significant results.

previous step showing Market Potential as the only significant variable, the same experiment was performed using only Total Market potential instrumented by its foreign element as the explanatory variable of location coefficients. Results are shown in Table 4.10.

Table 4.10: GMM: Instrumented Market Potential effect on localization, pooled data

Variable	**Primary**	**Secondary**	**Tertiary**	**Personal**	**KIBS**
log TMP	-0.818***	0.099***	0.055***	0.053***	0.054***
	(0.017)	*(0.004)*	*(0.002)*	*(0.002)*	*(0.003)*
Constant	16.597***	-1.127***	-0.144***	-0.346***	-0.086
	(0.354)	*(0.087)*	*(0.045)*	*(0.061)*	*(0.054)*
r-squared	0.28	0.17	0.13	0.08	0.16
N	12343	11818	12358	9278	12301

Dependent variable: Hoover's index of localization by county. Independent variables: Logarithm of Market Potential by county instrumented by Logarithm of Foreign Market Potential. Coefficients from IV regression with year and region fixed effects for the years 1930, 1950, 1980 and 2010, where (*), (**) and (***) correspond to significantly different from zero coefficients at 10%, 5% and 1% confidence level. Standard errors clustered by region reported under the coefficients. *Source: own calculations.*

GMM regression results provide evidence for Market Potential even when there is evidence for it being endogenous. Foreign Market Potential is a strong instrument for Total Market Potential. The resulting coefficients of the instrumented variable are significant for all the sectors and show the expected sign: positive for all sectors and negative for agriculture. However, this regression shows that prior coefficients were probably biased. According to these results, Market Potential has the strongest effect on agricultural production, although it is a negative one. In other words, newest industries will allocate where there is greater Market Potential which is where agriculture is not present. These positive results lead one to question whether the purely endogenous component of Total Market Potential (Self-Potential) could be analyzed in the same manner. The analogue analysis of self-potential yielded surprising results. The self-potential coefficient instrumented by foreign market potential was always significant. It replicated the sign that was obtained in the previous experiment, but this time the coefficient was more extreme. The R-squared of the regression doubled in all cases except in the secondary sector, showing that in fact, local market potential was more important for explaining the allocation of employment for services than for total market potential.

Surprisingly, the impact of log Self-Potential is significantly larger for the agricultural sector than the tertiary sector. Market size seems to have a greater effect on the localization of agricultural employees than any other sector. More than this, the R-squared of the primary sector is significantly bigger than for KIBS in this regression. These coefficients seem to point at why KIBS do not allocate in certain areas based on the persistence of specialization in the primary sector. If the size of the local market is small, very skilled service employees are less likely to live there, urbanization is less likely to be high and the transmission of local spillovers is more difficult. The successful land exploitation of a county persists through time in the most appropriate areas and prevents the settlement of industries that require IRS.

Table 4.11: GMM: Instrumented Market Self-Potential effect on localization, pooled data

Variable	**Primary**	**Secondary**	**Tertiary**	**Personal**	**KIBS**
log Self-Potential	-1.715***	0.211***	0.114***	0.099***	0.114***
	(0.037)	*(0.009)*	*(0.004)*	*(0.004)*	*(0.005)*
Constant	27.638***	-2.536***	-0.857***	-1.008***	-0.837
	(0.597)	*(0.151)*	*(0.070)*	*(0.088)*	*(0.081)*
r-squared	0.47	0.15	0.25	0.19	0.30
N	12343	11798	12338	9258	12276

Dependent variable: Hoover's index of localization by county. Independent variables: Logarithm of County Self-Potential instrumented by Logarithm of Foreign Market Potential. Coefficients from IV regression with year (1930, 1950, 1980 and 2010) and region fixed effects, where (*), (**) and (***) correspond to significantly different from zero coefficients at 10%, 5% and 1% confidence level. Standard errors clustered by region reported under the coefficients. *Source: own calculations.*

These tests seem to favor the result that Market Potential determines the allocation of all industries. However, the link between Market Potential and agricultural production is so strong that there seems to be an underlying relationship between Market Size and natural endowments. These results may point in the same direction as Davis and Weinstein [2003], who claim that physical geography may be the most important determinant of economic geography.

4.5 Conclusions

Prior work has stressed both the contribution of resource endowments and market potential to the geographical allocation of production. However, most studies have relied on manufacturing data, neglecting the worth of an important part of the economy. This investigation is motivated by the gap in the localization literature regarding the service economy, the motor of US employment dynamics in the late 20^{th} century according to Desmet and Fafchamps [2004]. The observation that Knowledge Intensive activities tend to localize in densely populated metropolitan areas more than proportionally motivates this study, which constitutes the first attempt to understand the causes of localization of the service economy based on the methodology of Kim [1995]; Krugman [1991] and Rosés [2003], among others.

The conclusions that arise from this investigation are manifold: firstly, relative factor endowments were found to be significant in determining industrial localization, especially through interaction terms between complementary factors of production for each industry. Moreover, technological improvements have changed the use in which factors of production interact, increasing the relative intensity of capital in all sectors (individually or through its interaction with labor). However, introducing Market Potential in the equation dispels the significance of endowments. In fact, Market Potential seems to explain a large part of the location of economic activities. More specifically, this analysis has identified that its local element (county Self-Potential) is the main contributor to localization patterns of the service economy. In other words, Increasing Returns to scale (spillover effects, closeness to specialized labor force and competitors and providers) are originated locally and attract more services into the city, confirming that many studies have overlooked the local nature of IRS by choosing geographical units of analysis that are too broad (Kim [1995, 1998]).

This investigation points at NEG as the sole explanation of localization, instead of the mixed model of localization defended by Dumais et al. [2002], not only for services but for all sectors. The most surprising finding is that market access seems to be incompatible with the localization of agricultural production, which requires the intensive use of land. The evident incompatibility between the snowball effect of increasing returns and the long term persistence of land exploitation is obvious from this perspective. This study therefore indicates that the good preconditions for agricultural production prevent the development of the service economy through the persistence of agricultural agglomeration and its conflict with large market potential.

The analysis of the service economy has proven that increasing returns to scale explain localization as long as the analysis is performed on the appropriate geographical scale, not only in the service economy, but in any sector. However, the strong negative relationship between agriculture and market potential seems to point to physical geography as a constraint for increasing returns. Although these results underscore the NEG side of the debate, there is some hope for the defenders of the mixed model. Nevertheless, these results present broad data on personal and knowledge intensive sectors in contrast with aggregated manufacturing and agriculture. Future work could explore the link between Market Potential and the persistence of natural geography that could be determining the history of services.

CHAPTER 5

Knowledge shocks diffusion and the resilience of regional inequality

> An investment in knowledge always pays the best interest.
>
> Benjamin Franklin, 1758

This chapter provides a simplified method of exploring the geographical limits of a knowledge shock over the long run. Using a geographically decomposable distance-weighed sum of world GDPs by county, differences in differences regression analysis shows that a new university will not only have a positive impact on the local economy, but also on the GDP of nearby counties. Furthermore, challenging the conventional wisdom that knowledge spillovers affect the local economy, this study provides evidence that the effect expands to the whole nation although its strength dilutes with distance. Consistent with the education literature, this investigation provides evidence that the shock will make the relative GDP of foreign competitors worse-off. Results are persistent in the long run, although the effect of time is also decreasing. Results are robust to potential endogeneity related to the self-selection of prosperous allocations for new academic institutions.

JEL classification: L8, N72, R11, O18.
Keywords: New Economic Geography, Spillovers, U.S. Counties.

5.1 Introduction

The search for policies to fight the regional persistence of inequality is crucial in industrialized economies. A number of contributions to the economic history literature have shown that high-value added sectors tend to cluster in particular regions and promote a process of de-industrialization in the rest of the economy, creating long-term divergences that lead the population to move toward these clusters in search of higher income.[1] These policies might include national subsidies, tax reductions, federal minimum wage increases or locally planned projects that promote business creation or service provision like new airports, freeways or the improvement of local administration to hopefully increase or maintain the population (Moretti [2002]).

In 1949, the Federal Government of the United States decided to investigate the power of nuclear energy. The fear that nuclear power could harm the health of the population led to the search for an isolated desert to locate the nuclear energy research facility.[2] In less than two decades, Idaho, formerly known as the *Potato State*, was among the top-100 biggest metropolitan areas in the country. The population of Idaho Falls and its surrounding counties had increased, had become much more skilled, and enjoyed higher living standards. The creation of this national research facility led to a presumably unexpected upswing in terms of population and income that accumulated further growth in nearby counties. This study explores the geographical impact of a knowledge shock as urged by two fathers of the New Economic Geography (Fujita and Krugman [2003]) and challenges the conventional wisdom that knowledge spillovers act locally. Evidence shows that the effect of local investments tend to spread to the whole nation and make foreign competitors comparatively worse-off, *ceteris paribus*. These conclusions prove that development processes should be assessed in spatial, territorial and scalar terms and provide optimistic prospects for those in favor of policy decentralization and devolution (Pike et al. [2007]; Rodríguez-Pose and Gill [2003]). Local policy-makers that can contest regional inequality, but also promote national competitiveness through micro-investments.

[1] Enflo and Rosés [2015] explore the Swedish late industrialization period and the policy efforts to decrease regional inequality, Autor et al. [2008] do the same for the US in the last few decades.

[2] National Reactor Testing Station.

I propose an experiment that considers the appearance of a new academic institution as a knowledge shock and performs a common differences in differences methodology to observe the significance of the knowledge shock in comparison with an untreated control group. The main contribution of this paper is the simplification of the methodology to obtain results that would usually require complicated spatial econometrics: by disentangling the county geographical impact of GDP into layers, I can test the significance of the shock at different levels, avoiding the nuisance of complicated county neighboring matrices. An additional contribution is the consideration of the whole range of counties in the USA rather than only cities or metropolitan areas, which usually lead to biased conclusions.

The basic empirical results show that the establishment of new universities during the 20^{th} century had a positive impact not only on the local economy and its nearby counties, but also on distant locations within the nation. Moreover, *ceteris paribus*, a new academic institution in any county of the USA made foreign competitors relatively worse-off in terms of GDP. The effects of knowledge shocks seem stronger in closer locations and milder, but significant, in more distant areas. Similarly, the effect of the shock seems to slowly wear-out over time. However, these effects seem to persist over the whole century. Testing the significance of the shock in per capita terms shows that the effect in productivity is only local and the shock affects nearby regions through a multiplier effect as in Moretti [2010].

The remainder of the chapter is organized as follows. Section 2 discusses the historical background on the higher education system of the United States in context with urban growth during the last century. Section 3 develops the theoretical framework and main hypothesis, followed by a description of the variables and the empirical strategy. Section 5 presents results and robustness checks and Section 6 concludes.

5.2 Historical background

The economic history of the United States is a story of skills and human capital. Its academic institutions have not only turned the Human Capital Century into the American Century (Goldin and Katz [2009]), but have also driven the divergence of regional economic performance over the century. While the relevance of academic and research institutions has only recently become evident, it has been an important driver of economic growth for a long period of time. The following paragraphs summarize the origins of the American higher education system.

As a consequence of the fear that the imprudent European tendencies would corrupt their souls, the Puritans who travelled to the New World launched the precursors of college institutions in the first settlement allocations at the end of the 17^{th} century. These would become the well-known institutions of Harvard, Yale, and William & Mary Universities. Originally these were meant to produce educated gentlemen whose "business (was) to spread religion and learning among mankind" [Geiger, 2014, pp. 11]. The evolution and emergence of these institutions was slow and always related to local religious elites.

The initial courses included theological and literary education and grammar subjects; the introduction of ancient languages like Greek and Hebrew to study sacred original texts motivated the introduction of logic and other mathematical areas, but the low depth of scientific knowledge did not yet reflect intellectual advances in Europe until well into the 18^{th} century. Eventually, the American elite accepted that scientific knowledge could make laborers more productive, and thus Newtonian scientific doctrine started to be taught in US colleges. By 1836 the academic system even allowed higher education for women. However, the elitist character of these institutions forced the imbalance between theoretical science and practical applications for gentlemen. Under the rising scarcity of mechanical and agricultural engineers, fostered by the railroad boom of the 1840s, some non-college alternatives started to arise in the cities like mechanics and polytechnic institutes.

The role of private sector investment went hand in hand with the growth of "useful knowledge". By the second half of the 19^{th} century, America had turned into a world reference of technological advance. The land grant promoted by President Lincoln (Morrill Act, 1862) helped revolutionize higher education by providing states with public lands to create universities specializing in agriculture, mechanics, and military tactics. This was the beginning of mass higher education, as congressman Morrill envisioned the existence of a college in each state as an opportunity "*accessible to all, but especially to the sons of the toil . . . thousand willing and expecting to work their way through the world by the sweat of their brow*" [Geiger, 2014, pp. 281].

In the 20th century, the higher education system offered students the widest range of opportunities in the world (around 1,400 institutions offering bachelor's degrees in several areas). As Goldin and Katz [2009] put it, the system was geographically spread and accessible to all kinds of economic and intellectual backgrounds. While the role of mass education has been crucial for the productive structure of the country, the location of Universities seems to create regional divergences in the US territory. First, colleges were established even when secondary education was not yet standardized, so that the mass movement toward college had to be led by the diffusion of secondary schooling. Although both kinds of institutions were originally decentralized, public and open to all genders and races, a minimum scale was needed to create such institutions. Just as the first colleges appeared in the first populated settlements, secondary schools were allocated in towns with at least 3,000 people in 1903 (Goldin and Katz [2009]). This threshold set a precedent for the divergence between rural and urban growth.

The effects of academic education on growth are directly visible on labor productivity through an increase in the quality of the workforce (see Caselli and Coleman [2002]), but there are also indirect effects: higher income generated by labor productivity raises physical capital investment and the capital to labor ratio; also, the quality of the workforce facilitates the diffusion of innovations and ideas. Thus, regions with higher levels of education are expected to grow faster. At the beginning of the century, all the regions below the population boundary would be at a practical disadvantage of growth opportunities, although evidence suggests that town size is negatively correlated with school attendance rates [Goldin and Katz, 2009, pp. 224]. This negative correlation is explained by the relative opportunity costs of schooling as well as the quality derived by a higher share of students per school in biggest cities. Nevertheless, the demand for skills gradually changed in the cities. US occupational data from Edwards [1943] show that in the late 19th

century, only 10 per cent of the workforce was engaged in jobs requiring education beyond secondary school, by 1920 more than a quarter of the jobs required high school or college education. The proliferation of white-collar occupations was accompanied by the structural change of the economy.

Regional specialization determines the average level of human capital: while mining regions are associated with relatively lower effects of knowledge spillovers and have remained small, cities that grew around the textile industry were crowded with unskilled labor and only grew at the beginning of the 20$^{\text{th}}$ century. In contrast, commercial towns that specialized in skill-intensive activities like accounting, advertising and law tended to become large cities over the same period (Chicago, Boston, New York). This way, in the 1930s the population in Idaho Falls was specialized in the production of agricultural products and their low wages responded to their skills level. After the knowledge shock, represented by the establishment of the Nuclear Research Center, their production bundle diversified by including valuable knowledge intensive services (nuclear energy research), and the population grew by attracting scientific employees that earned much higher salaries, fostering the creation of new businesses and, eventually, raising living standards.

The analogy between the Human Capital Century and the American Century is not only motivated by the higher human capital increase of the American labor force over the century, but also because the change was not comparable to the standards of any other nation, which led to the great divergence between the US and the rest of the world and also the increasing domestic inequality within the country. The next section explores the different views proposed in the literature for exploring the role of educational differentials on regional disparities, and explains how this chapter differs from spatial models to account for knowledge shocks across space and time.

5.3 Theoretical framework

The link between urban growth and human capital has been widely studied. Glaeser et al. [2014, 1995] and Simon and Nardinelli [2002], among others, identified human capital and skills as an important factor behind the growth of cities after WW2. The theoretical base comes from the evidence that the existence of urban clusters is derived from the positive external effects of human capital (increasing returns to scale); without these, rational citizens would not bear the costs of moving to crowded clusters just as observed by Lucas [1988]. Endogenous growth models argue that innovation comes from the mix of labor, human capital and knowledge. In this sense, the proliferation of institutions providing human capital is expected to promote higher growth and urbanization. A crucial question is whether urbanization is exogenous to the localization of new academic institutions or whether there is a self-selection process instead.

This chapter offers a view in which the localization of a new academic institution acts as a positive knowledge shock to the county. The objective is not to show that a shock improves the local economy, as that has already been repeatedly proven on several occasions (Anselin et al. [1997],Goldin and Katz [2009], Krueger and Lindahl [2001]). Instead, this research addresses the extent to which local spillovers spread geographically and whether these effects persist over time. The analysis of such shocks on economic activity is not new in economic history, however the spatial diffusion of local shocks over the long run has never been investigated with this much detail. Recently, the New Economic Geography literature advocated for the need for this kind of analysis (Fujita and Krugman [2003]) to prove that development policies can act through scalar, spatial and territorial redistribution (Pike et al. [2007]).

The literature on urban economics has explored the effects of external shocks on the spatial distribution of economic activity in several areas, finding mixed results. The pessimistic view can be well exemplified by Redding et al. [2011], who use the German division after WW2 and its later reunification as a natural experiment of an external shock to the location of the air transport industry. They show that neither endowments nor market access differentials are big enough to explain the reallocation of the air hub from Berlin to Frankfurt. They suggest that the differential between local economic activity is not a good predictor either, instead, the selection of Frankfurt as the localization of the main air hub in Germany responds to a relatively small external intervention (US setting Frankfurt as the main air transport base) that influenced the location of the new hub given the large investments required for its functioning. Their conclusion that German reunification was not a sufficiently big shock to return the hub to its pre-war location casts evidence against the ability of policy to shift economic activity from an existing steady state. On the same track, Davis and Weinstein [2002] showed that the allocation of cities in Japan was persistent over 8 thousand years and the massive destruction of the atomic bombs did not alter the original allocation of the main cities. This localization persistence is explained by fundamentals and the degree of inequality is accounted for by increasing returns, but again, the effect of shocks is only temporary and does not change the steady state. WW2 bombings in Germany also offer an opportunity to analyze the reconstruction of markets in their original cities. According to Brakman et al. [2004], the effects are significant for both areas; however the bombings affected the reallocation and growth of cities permanently in East Germany and temporarily in West Germany, where increasing returns slowly took over city growth path in the long run.

On the other hand, a number of studies reveal opposing conclusions. Local shocks generated by the expansion of transport facilities like the railroad (Atack et al. [2010]) or highways (Baum-Snow [2007]) have provided evidence on changes in the urbanization rates of counties and cities in the mid-19th and mid-20th century. Other authors have proved the significance of negative shocks like wars, or factor input shortages. For example, Hanlon [2014] studies the American cotton supply drop during the Civil War, finding temporary growth effects and permanent level effects on population in British cotton towns.

These contradicting views on the effects of external shocks are generally looking for changes in steady state aggregates or local changes in levels or growth magnitudes in comparison to a prior situation; however, the effects of local shocks on neighboring areas remains largely unexplored. Hornbeck and Keniston [2014] have surveyed this area by performing a very local study on the impact of the Great Fire of Boston in 1872 on land prices of unburned nearby areas. They argue that in a period of intense growth, the fire motivated a reconstruction that increased the property values of the burned areas more than proportionally. This was a consequence of the parallel reformation of nearby buildings, showing that the reconstruction led to the spread of local spillovers. In the same line of work, Simon and Nardinelli [2002] find that the extent of spillovers works at the city level.

Scholars have tried to study the economic impact of research institutions following two paths. Taking a microeconomic perspective, some scholars evaluate single-case institutions through the analysis of economic fundamentals like spending, investment and employment rates or more sophisticated variables like the creation of spin-off firms, or the assessment of university-linkaged firms; others use surveys on firms evaluating the local effects of an institution on their decisions. Using a macroeconomic approach, economists like Grilliches [1979] and Jaffe [1989] have generated models based on knowledge production functions derived from the location of institutions, while others have designed cross-sectional econometric experiments that evaluate the economic impact of these institutions. These four approaches have different benefits and drawbacks and are efficiently summarized in Drucker and Goldstein [2007]. In this perspective, the framework I use follows an econometric cross-section experiment on different years (because the data set is actually a panel).

In this area of work, Anselin [2000], using a knowledge production function *à la* Grilliches-Jaffe, showed that universities generate local spillovers across particularly high technology sectors like Electronics and Instruments, extending up to a 75-mile range to the boundary of Metropolitan Areas, while Drugs and Chemicals and Machinery showed no significant spillover effects. Positive evidence on university R&D was previously suggested at the state level by Anselin et al. [1997] using the same approach. Additional studies have proven that industries where new economic knowledge plays an important role have a higher propensity to cluster together (Audretsch and Feldman [1996]) in regions and also across nations (Ciarli et al. [2012]). These positive results offer an opportunity to policy-makers who wish to design economic policies to promote regional growth under the influence of increasing returns to scale at various geographic levels. However, Audretsch et al. [2012] underline the need to be cautious about the potential crowding out effect of private research activity under the provision of publicly funded research.

This investigation extends empirical evidence on three different aspects: first, the geographical framework covers the whole territory of the USA using smaller geographical areas than States or Metropolitan Areas. More specifically, the use of counties increases the number of observations from 50 or 125 to more than 3,000; in addition, it provides a much better view of the diffusion of local spillovers by including not only cities or metropolitan areas, but also rural counties, whereas the traditional literature is generally biased towards the isolated analysis of urban areas. Secondly, the sample extends evidence to five benchmark years, presenting a longer-term view of results. Lastly, instead of considering the use of a spatial lags model (Anselin [2000]; Anselin et al. [1997]), the methodology explores the spatial extent of spillovers using an alternative measure: a distance-weighed sum of GDP that can be decomposed at different geographical scales to identify the extent of the shock.

The use of this framework allows one to ascertain the impact of a new university over distance and time. Say, a new university is established in Fresno in 1911; by 1915 it will have presumably attracted some students that will eventually become part of a pool of skilled workers. With some luck, the pool of skilled workers can foster the creation of new firms that may capture the knowledge spillovers from the university. The increase in local demand will attract other kinds of workers and services with the consequent rise of local income and wages as explained by Moretti [2004].

The central question is whether this shock will affect the well-being in adjacent counties such as San Benito or even spread to more distant counties like Inyo. Further, will this shock expand to Nevada? Will it maybe affect Kansas? How long will the impact last for any of these layers? The following section outlines the way a distance-weighed GPD index can provide a measure of the effects of a knowledge shock and describes how it has been obtained and provides a description of the variables and their sources.

5.4 Data and empirical strategy

5.4.1 The data set

The current data set is a panel on distance-weighed Total GDP observations by county over five benchmark years during the 20$^{\text{th}}$ century (1930, 1950, 1980 and 2010). Thus, the number of observations amounts to a total of 12,512: five time-series observations for 3,130 counties. This measure provides the means to investigate the geographical expansion of the shock econometrically using a simple differences in differences model. The distance-weighed sum of GDPs is similar to the concept of Market Potential, originally defined by Harris [1954] as the sum of the GDPs of potential commercial partners weighed by bilateral transport costs or distances. This specification takes into account that two adjacent counties will have a greater chance of trade than two distant counties, with no need to use a neighboring matrix. In this sense, it can be defined as a location's accessibility to the other markets, and can be formulated as:

$$MP_i = \sum_{(j-1)}^{(j-n)} \frac{M_j}{d_i j} \tag{5.1}$$

Market Potential accounts not only for local GDP, but also for all potential trade with neighboring counties within a state, with the nation as a whole, and even with other nations; this is useful because it provides a detailed view of the extension of the market based on bilateral transport costs and the size of other markets. More background information on Market Potential can be found in the appendix. In a similar way, the distance-weighted total GDP can be split into different components to address the extension of the impact of a new university.

Distance-weighed Total GDP observations for each county have been constructed following the methodologies used by Crafts and Mulatu [2005] and Martínez-Galarraga [2012], who compute Market Potential using its different geographic components. This data set provides visibility on Foreign, Domestic, State and county GDP self-impact as well.

Table 5.1: Geography components participation on county distance-weighed GDP

	Average Participation				**% Growth rates**		
Component	**1930**	**1955**	**1980**	**2010**	**30-50**	**50-80**	**80-2010**
Foreign	80.66	50.80	73.59	87.58	33.44	89.98	82.27
Domestic	19.34	49.20	26.41	12.42	83.12	73.18	55.42
State	*14.59*	*34.36*	*19.32*	*9.12*	*82.21*	*74.18*	*55.33*
Neighbors	*3.11*	*11.64*	*5.41*	*2.49*	*87.14*	*69.99*	*55.56*
Local	*1.65*	*3.20*	*1.68*	*0.81*	*78.39*	*72.37*	*55.9*
TOTAL	100	100	100	100	57.89	85.52	78.89

Source: Own calculations from US Census Bureau, Internal Revenue Service for Domestic data and WTO (2005) and Maddison (2010) for international data. More information in Appendix.

One of the main issues raised in Table 5.1 is that the indicator has been increasing through the whole period, and most of the effect comes from the Foreign component, revealing that the commercial power of the United States has only changed recently favoring other regions. Meanwhile, county self-potential represents a small share of the domestic component.

This basic database is combined with an additional collection of data on Universities and Educational Institutions in the United States, coming from The Institutional Data Archive on American Higher Education (Brint et al. [2003]). This source contains academic data on 384 four-year colleges and universities in the United States based on stratified random sampling to over-sample elite institutions. The sample includes all highly-selective colleges and research universities in the United States, as well as other selective colleges and research universities, masters-granting comprehensive universities and non-selective baccalaureate-granting institutions. The IDA sample does not include business colleges, art schools or any other specialized institution, neither profit-institutions nor two-year program colleges. This release incorporates longitudinal and cross-sectional information on institutions, university systems, programs, academic departments, earned degrees and institutional academic rankings over time. The main variables of interest within this sample are the location of Educational Institutions, the year of establishment of these institutions and how research-intensive their activity is. This information has also been merged with the number of academic establishments provided by the County Business Patterns to gain proper visibility on the counties with no academic institutional presence.

The random relation between academic institutions is classified according to the Carnegie Classification, the leading framework for describing institutional diversity in US higher education for the past decades, (McCormick [2006]). This framework has been widely used in the study of higher education, as a way to represent and control for institutional differences and to ensure adequate representation of sampled institutions, students, or faculty. The classification has changed over time; however, the main groups are easily traceable over the period. To simplify, this database contains a numeric indicator variable from one to four, depending on the average category each institution has been over the base year in which the Classification was released. The basic categories used in our sample according to research activity includes:

- Doctorate-granting Universities: When the institution awarded at least 20 research doctoral degrees during the update year (excluding doctoral degrees that qualify professional practices, such as MD, PharmD, DPT, etc.).
- Master's Colleges and Universities: includes institutions that awarded 50 or more master's degrees and fewer than 20 doctoral degrees during the update year.
- Baccalaureate Colleges: when baccalaureate degrees represent at least 10 per cent of all undergraduate degrees and fewer than 50 master's degrees or 20 doctoral degrees were awarded during the update year.
- Associate's Colleges: when all degrees are at the associate's level or bachelor degrees account for less than 10 per cent of all undergraduate degrees.

The dataset also takes into account several control variables such as the year the county was part of the United States, whether it was one of the thirteen original colonies or the date of its official establishment as part of a State.

5.4.2 Empirical strategy

This chapter aims to demonstrate that although income differentials are persistent over time, a human capital shock in a region will increase growth in the long run, not only in that region, but also in neighboring regions. The chapter approaches this analysis by using a differences in differences regression analysis of the shock using a random sample of counties with academic institutions and a random control group of counties with no academic presence at all. These regressions compare the evolution of the distance-weighed GDP impact and address the significance of the knowledge shock in the treated group using the usual baseline specification:

$$\begin{aligned} l(GEOimpact) = \beta_0 + \beta_1(Treatment_{i,t} + \beta_2(AfterTreatment_{i,t}) + \\ + \beta_3(Treatment_{i,t} * AfterTreatment_{i,t}) + \beta_4(Controls) + e_{i,t} \end{aligned} \tag{5.2}$$

Where the different geographical elements are regressed on the variable *Treatment*$_{i,t}$ (which equals one if the county is in the Treated Group and zero otherwise), *After treatment*$_{i,t}$, which equals one in the period after the new university was established and the dummy interaction of both variables (*Treatment*$_{i,t}$*After *treatment$_{i,t}$*), which equals one only when the county is within the Treated Group and after the treatment has taken place. Additionally, the regression controls for the different benchmark years at which the shocks take place. Using this approach, the main interest is the significance of the coefficient of the interaction term, beta$_3$, that assesses the difference of the market potential gap between the treated group and the control group after the shock has happened.

5.5 Results

At first glance, a quick examination of the observations with and without academic institutions samples leads to preliminary optimism regarding the potential findings from this analysis. The sample contains the 300 observations which host an academic institution in 2010 provided by the IDA database and an additional 300 random observations of counties with no academic establishment obtained from the County Business Patterns report performed by the US Census Bureau for each benchmark. As Table 5.2 reports, the long-term evolution of urbanization reveals that the treated group has evolved from the rural economy much faster than the control group although they started-off at very similar levels in the first year. Consistent with the consensus found by urban economists, in this sample the effects of a college education shock are positively correlated with an acceleration of city growth as proposed by Glaeser et al. [1995].

Table 5.2: Rural and urban counties in the sample

	Treated Group		**Control Group**	
	Rural	Urban	Rural	Urban
1930	297	3	299	1
1950	175	125	265	35
1980	121	179	235	65
2010	15	285	154	146

Follows the classification of Rural County provided by the US Census on each benchmark year.

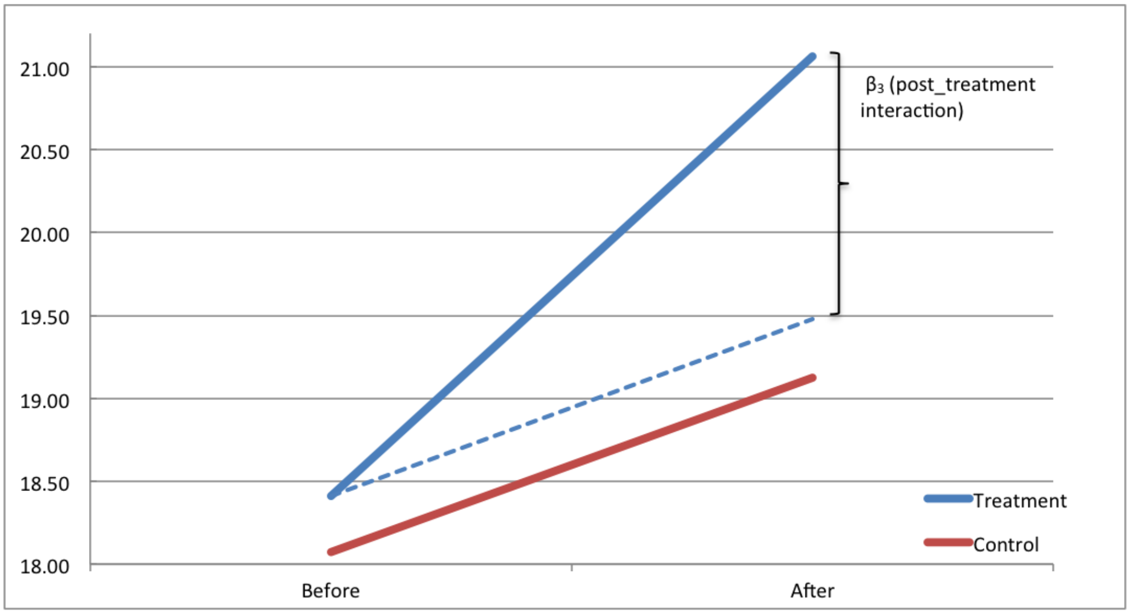
The initial experiment consists of finding a causal effect between the establishment of new academic institutions and this growth differential by comparing the situation of the treated group and the control group before and after the shock. Table 5.4 shows the pooled OLS regressions of the geographical components of the distance-weighed sum of GDPs on the dummies related to the knowledge shock created by the new universities controlling for the year of the change. The resulting coefficients show that the shock has a positive effect on the self-potential of counties and its neighboring counties within the state at 1 per cent significance, but there is no evidence that the effect expands further. Notice the high R-squares of the regressions of the Local Impact and Neighbor County Impact in comparison with the rest of the components; other unobserved variables affect GDP of States and Foreign competitors.

The significance of the shock on the local element is not unexpected, as it is consistent with the central premises of education economics. Many have argued for the simultaneous causality of this result though, and have even posed education as the 'weak link' of the growth literature: higher local GDP (the central element of the indicator of the Local element of the distance-weighed GDP) fosters a higher provision of services and vice-versa.[3] Proving the causality behind such a relationship is beyond the scope of this investigation that relies on the findings of scholars like Goldin and Katz [2009],Moretti [2002], and Rauch [1993].

The most interesting result comes from the positive and significant coefficient of the interaction term in the Neighboring Counties regression. The neighboring counties GDP component might be correlated with the local GDP component, however it is bound to be affected by many other independent variables. Thus, controlling for yearly fixed effects and regional effects adds reliability to the results of the neighbors impact regression. The effect of the shock reports a 7 per cent increase of the impact on neighboring counties in the Treated Group than in the Control Group at one per cent significance, as illustrated in Figure 5.1. These results yield evidence of the significance of the treatment on nearby areas. However, one might question these results by addressing the self-selection of counties to the location of new universities even by abstracting from the obviously endogenous character of self-potential. It is possible that new universities might be allocated in areas where high growth is already expected. The decision to establish a new academic institution might not even be taken locally but at a more global scale as in the case of the Morrill Land-Grant Acts (1862), where federal incentives motivated the creation of state universities by state governments. State governments could have selected these allocations in areas with positive growth prospects.

[3] Krueger and Lindahl [2001]; Mankiw [1997].

Figure 5.1: Effect of the new university on neighboring counties with Random Control Group



Source: from own calculations.

This intuition leads to the hypothesis that the Treated Group counties might be special. In order to control for this potential self-selection, an alternative synthetic random control group that shows similar initial characteristics to the ones in the treated group could be used to perform the same analysis, replicating the technique developed by Abadie and Gardeazabal [2003]. This way, the difference-in-difference coefficients will only show the variance related to the treatment, eliminating the bias from the intrinsic heterogeneity of the samples.

5.5.1 Synthetic control method

Finding a control group that is synthetically equivalent to the Treatment Group implies restricting the sample to comply with several conditions that are met by the treatment group at the beginning of the period. In this sense, the Synthetic Control Group must start-off at a level similar to the treated group. Indeed, from Table 5.3 it is visible that the Treatment Group is a special sample of counties and rather different to the the Random Control Group used in the previous section. An examination of the initial levels of urbanization was not a sufficient way to analyze the impact of new academic institutions.

The Treated Group does not only differ substantially from the average level of primary sector employment of the population, but is almost half of that of the Random Control Group. The shares devoted to other sectors consequently also differ, thus showing that our counties in both samples evidence very different productive structures and pools of labor. Additionally, the pattern of growth seems to have diverged in both samples, where population from the Control Group seems to be stagnant between 1930 and 1980 while the counties in the Treated Group have increased their population by almost 50 per cent in the same period. It seems, thus, that the previous analysis considers two rather contrasting samples of counties, where clearly most of the components of the weighed GDP sum amount to different levels. Consequently, the alternative random control group has been forced to meet certain criteria, such as a similar productive structure or a closer local component sum of distance-weighed Total GDP, finding an alternative sample of 300 counties with no academic presence with a similar productive structure and distance-weighed Total GDP.

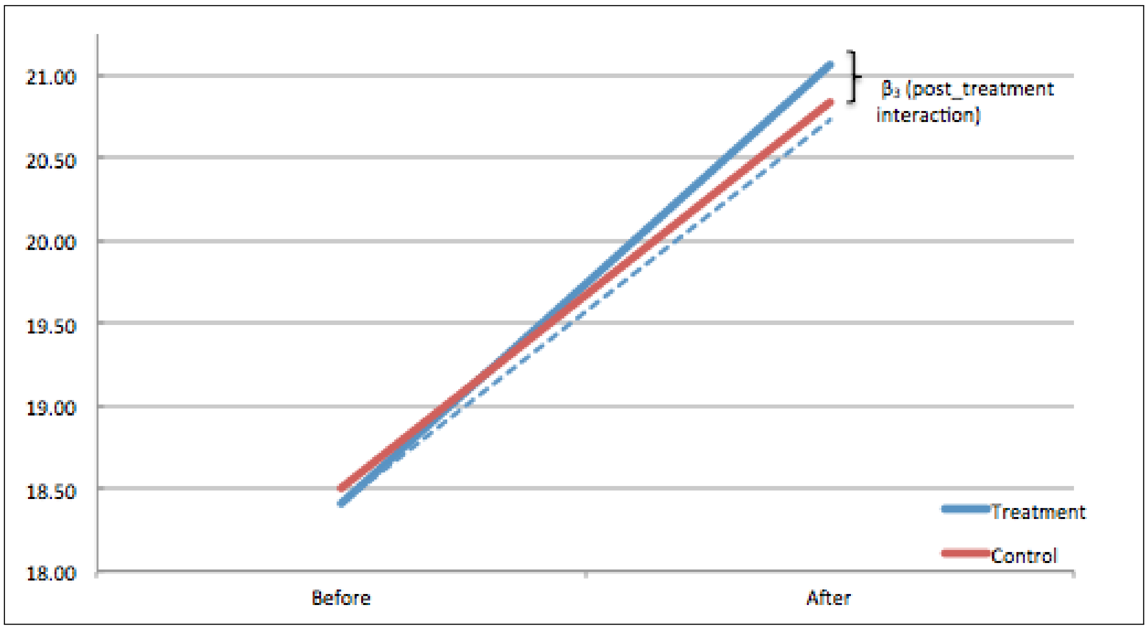
Table 5.3: Descriptive data from samples and population

Group	All counties	Treatment	Random	Synthetic
Establishments		=1	=0	=0
	N=3128	N=300	N=300	N=300
Average Indicators in 1930	T=4	T=4	T=4	T=4
l(Distance-weighed Total GDP)	18.284	19.154	17.942	19.395
l(Local component)	14.347	14.865	14.237	14.903
l(Neighbor Cty. component)	16.073	16.544	15.955	16.691
l(States component)	15.911	15.708	15.949	16.236
l(Foreign component)	16.277	17.709	15.601	17.707
Employment Share %				
Primary Sector	0.487	0.289	0.578	0.279
Secondary Sector	0.132	0.256	0.068	0.259
Tertiary Sector	0.380	0.456	0.354	0.461
Population growth (1930-1980)	0.113	0.450	-0.051	0.382
Rural counties in sample				
1930	3117 (0.99)	297 (0.99)	299 (0.99)	300 (1.00)
1950	2844 (0.91)	175 (0.58)	265 (0.88)	279 (0.93)
1980	2462 (0.79)	121 (0.40)	235 (0.78)	234 (0.78)
2010	1325 (0.43)	15 (0.05)	154 (0.51)	67 (0.22)

Source: own calculations.

In line with the previous case, note that the initial level of the Synthetic Random Group starts-off at slightly higher levels of urbanization than the treated group with an even smaller primary sector participation share, but the rate of urbanization is quite slower than that of the Treated Group with slower population growth from 1930 to 1980. There is still hope to find optimistic results regarding the shock.

Figure 5.2: Effect of the new university on neighboring counties with Synthetic Control Group



Source: from own calculations.

The analysis of the treatment with the Synthetic Control Group provides a better view of the treatment with unbiased estimators of the interaction group. This time, regression results show coherent signs and sizes and are significant in all the geographical components of the impact. According to Table 5.5, the significance and size of the local impact has decreased by a third, but the impact of the shock is now relevant in terms of counties, states and foreign counties. In other words, after a new university is established in Fresno, all the counties in California will experience an upswing in their GDP (*ceteris paribus*) significant at 1 per cent. Moreover, this shock will have a positive statistical impact on the rest of the counties within the country, although the effect will be smaller than for the neighbors within the same state, as opposed to the previous experiment with the Random Control Group. Additionally, the shock seems to make the domestic economy more competitive, creating a negative and quite sizeable Foreign GDP impact.

Table 5.4: Before & after effect of new university against Random Control Group

Impact	l(Total)	l(Local)	l(Neighbors)	l(States)	l(Foreign)
Treatment group	1.619 ***	0.311 **	0.336	0.003	3.277 ***
	(0.344)	*(0.161)*	*(0.229)*	*(0.603)*	*(0.435)*
After Treatment	-1.267 ***	-1.837 ***	-1.773 ***	-1.739 ***	-0.203
	(0.294)	*(0.094)*	*(0.126)*	*(0.072)*	*(0.171)*
PostTreatInteraction	0.230	0.318 ***	0.226 **	0.108	-0.739 ***
	(0.265)	*(0.132)*	*(0.114)*	*(0.069)*	*(0.218)*
N	1384	1380	1372	1384	1384
r-squared	0.396	0.490	0.629	0.304	0.408

Coefficients from the OLS difference-in-differences regression of the log of the geographical components of distance-weighed sum of GDPs to the shock of new universities. Robust standard errors clustered by state are reported under the coefficients. *** indicates statistical significance at 1%, ** at 5% and * at 1%. *Source: own calculations.*

Table 5.5: Before & after effect of new university against Synthetic Control Group

Impact	l(Total)	l(Local)	l(Neighbors)	l(States)	l(Foreign)
Treatment group	0.609 ***	-0.100	-0.094	0.087	1.492 ***
	(0.286)	*(0.196)*	*(0.178)*	*(0.494)*	*(0.483)*
After Treatment	0.126	-1.532 ***	-1.425 ***	-1.313 ***	1.145 ***
	(0.219)	*(0.087)*	*(0.102)*	*(0.110)*	*(0.334)*
PostTreatInt	-0.854 ***	0.276 **	0.317 ***	0.142 ***	-1.756 ***
	(0.186)	*(0.106)*	*(0.084)*	*(0.052)*	*(0.353)*
N	1388	1388	1388	1388	1388
R-squared	0.445	0.441	0.587	0,275	0,315

Coefficients from the OLS difference in difference regression of the log of the geographical components of distance-weighed sum of GDPs to the shock of new universities. Robust standard errors clustered by state are reported under the coefficients. *** indicates statistical significance at 1%, ** at 5% and * at 1%. *Source: own calculations.*

The knowledge shock, thus, seems quite important to future development both in terms of regional and global inequality; however, one could question whether quality could also be an issue. To control for quality, the same analysis has been repeated including the interaction of a variable that accounts for the average Carnegie classification rate of each institution to show whether more research prone institutions have a higher impact than associate college institutions. Results show no significant evidence on the difference associated to the level of research-intensity; in other words, there is no evidence of a higher effect of doctorate-granting academic institutions over Baccalaureate colleges; instead, any academic institution that creates a human capital shock will have a significant impact.

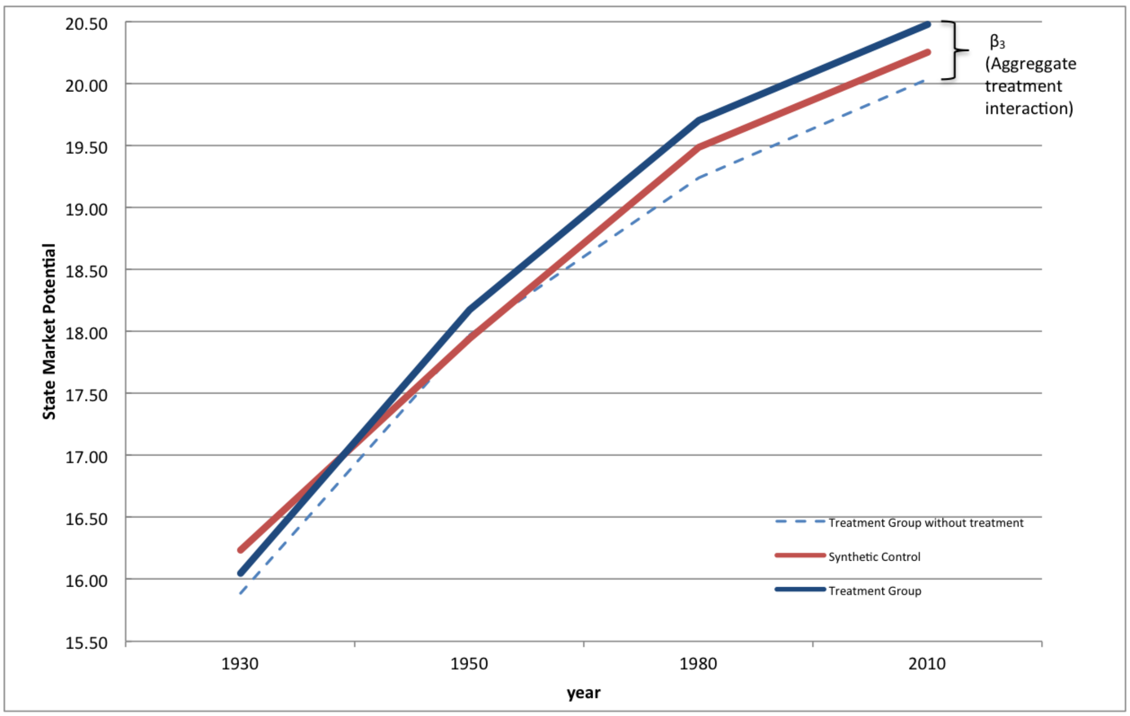
To improve long-term visibility, the same regression can be adapted to include several time periods to account for the date of the shock, where the independent variable is the final-benchmark year distance-weighed GDP impact. Table 5.6 shows the differences in differences regression of the long term impact of each shock. This table provides a much more detailed view of the shock that confirms that the local impact expands to nearby regions, diluting its effect with distance, while also having a significant effect in the international arena.

The effect of time seems to be similar: on average, the closer in time the shock is, the higher the effect becomes, although there seem to be discrepancies in the long run impacts of the different geographical layers: the domestic impact seems to last longer than the foreign impact according to the significance of the interaction treatment variables.

This new experiment shows that, for counties with similar levels of urbanization, a knowledge shock implies a regional acceleration of GDP growth that expands to nearby regions, creating a 'shock-wave' effect that also impacts faraway counties. Although the Synthetic Control Group seems to start slightly above the Treated control group in terms of distance-weighed Total GPD, the treatment has led the Treated Group to surpass the Synthetic Control Group by a lower, but still significant, impact as shown in Figure 5.2. Overall, the shock affects the relative position of the whole country in international perspective. This impact is independent of the type of institution that creates the knowledge shock. However, this before-after treatment analysis does not say much about the long-term effects of the shock and whether the change is persistent or temporary.

A possible interpretation of the time coefficients can come from the statistical significance of single time variables. It seems that time affects significantly the evolution of regional GDP weighed by economic distance. Firstly, transport costs decrease over time (see the Appendix for more details), and so does economic distance leading to an overall increase of the distance-weighed sum of GDPs. Second, path-dependency is rather crucial when determining income; initial GDP is a rather important factor of future GDP. Consequently, GDP ten years ago also matters, but to a lesser degree.

Figure 5.3: Long term effect of the new university on neighboring counties with Synthetic Control Group



Source: from own calculations.

According to Table 5.6, the impact of the shock has shorter term consequences for the local economy than for neighboring counties or states. If the treatment took place in the 1940s and showed its consequences in the 1950s, it is natural that the effect of the treatment is already taken into account in the time variable rather than the interaction variable. However, the interaction has longer term consequences for neighboring areas than for the local impact.

Table 5.6: Effect of new university against Synthetic Control Group in the long term

Impact	**l(Total)**	**l(Local)**	**l(Neighbors)**	**l(States)**	**l(Foreign)**
Treatment group	0.461 ***	-0.198	-0.312	-0.187	1.348 ***
	(0.317)	*(0.226)*	*(0.218)*	*(0.500)*	*(0.514)*
Before 2010	4.502 ***	3.644 ***	4.150 ***	4.015 ***	5.206 ***
	(0.216)	*(0.141)*	*(0.186)*	*(0.178)*	*(0.340)*
Before 1980	2.718 ***	3.158 ***	3.354 ***	3.247 ***	2.642 ***
	(0.166)	*(0.123)*	*(0.165)*	*(0.180)*	*(0.206)*
Before 1950	1.030 ***	1.758 ***	2.085 ***	1.706 ***	0.086 ***
	(0.171)	*(0.113)*	*(0.109)*	*(0.172)*	*(0.208)*
PostTreat2010	-0.707	0.373 **	0.535 ***	0.416 ***	-1.612 ***
	(0.243)	*(0.174)*	*(0.139)*	*(0.150)*	*(0.390)*
PostTreat1980	0.253	0.196	0.456 ***	0.404 ***	0.125
	(0.163)	*(0.155)*	*(0.135)*	*(0.147)*	*(0.217)*
PostTreat1950	0.190 ***	0.095	0.198 **	0.417 ***	0.310
	(0.185)	*(0.129)*	*(0.098)*	*(0.147)*	*(0.229)*
Constant	19.395 ***	14.890 ***	16.199 ***	1.236 ***	17.687 ***
	(0.289)	*(0.234)*	*(0.533)*	*(0.535)*	*(0.449)*
N	1388	1388	1388	1388	1388
R-squared	0.445	0.450	0.609	0.279	0.325

Coefficient from the difference in difference regression of the log of the geographical components of distance-weighed Total GDP sum to the shock of new universities. Robust standard errors clustered by state are reported under the coefficients. *** indicates statistical significance at 1%, ** at 5% and * at 1%. *Source: own calculations.*

This result may seem unreasonable, however I propose an interpretation related to increasing returns to scale. The local shock of a new university institution might be locally absorbed almost immediately, or in a few years, however, spillover effects may take some time to reach neighboring counties, and even more if they reach further. In practical terms, new researchers rapidly arrived to the Idaho Falls city as soon as the job positions started, but the expansion of the city took more time.

Similarly, the long-term interaction of the Foreign impact component might require some explanation. In this case, it seems to show a similar behavior to the Local impact, evidencing a single short term impact. Notice that the Foreign impact is assembled by the GDP of countries weighed by the economic distance (bilateral transport costs from each county to each county). Each country's GDP is affected by many more variables that are independent of the events in the USA, including the response to the opening of new academic institutions, which might have an analogue negative effect in US counties.

5.5.2 Local endogeneity test

Previous sections acknowledged the potential endogeneity of the local element, exposing the simultaneous causation between higher local GDP and higher provisions of services like university schooling posited by Mankiw [1997] and Krueger and Lindahl [2001]. Although proving the causality behind such a relationship is beyond the scope of this investigation, the variables used in this analysis allow for the performance of a simple extension that clarifies the link between local productivity and these knowledge shocks.

A slight transformation of the distance-weighed Total GDP sum to per capita terms has two consequences: first, it allows for the removal of the effect of the size of each of the participants in the sum of GDPs, while making distance much more important. Secondly, it allows one to understand the impact of a new knowledge institution in terms of productivity (as per capita GDP is a proxy for wages).

As a result, the new independent variable is the sum of the distance-weighed sum of per capita GDPs, where the foreign impact becomes relatively smaller than the domestic components. This is because the bigger size of countries is controlled for while the effect of its further distance becomes much more important. Likewise, the impact of close neighbors increases over distant counties, states and countries. Because the local component is computed as each county's GDP per capita over the great circle distance equivalent to its area, high wages and small areas lead to bigger local effects in the sum of the distance-weighed sum of per capita GDPs. In other words, big city counties with high productivities have relatively higher local components than large rural counties; furthermore, the total sum of distance-weighed per capita GDPs is driven by the local component as can be seen in Figure 20 in the Appendix.

Table 5.7 shows the result of performing the parallel regression between the Treatment group and the Synthetic Control Group in per capita terms. This time the results are quite distinct, leading to subtle differences between the growth of the economy and its development through improvements in labor quality. First, the effect of the shock on the State and Foreign components is no longer significant: the local shock does not affect distant economies. However, it seems that the local effect of the shock has now increased its size and significance and also affects nearby regions.

Additionally, the effect of a local shock does not only increase the local GDP per capita in the first period after the shock, but persists after one period on a lower scale, whereas the effect on the productivity of nearby regions is constrained to the first period of the shock.

These results show that knowledge shocks do affect the local economy as well as nearby regions. By controlling the potential causality between increasing counties and increasing service provision, this experiment has shown that the effect of knowledge shocks go beyond the size of the economy and affect the local productivity of regions and their neighbors, leading to multiplier effects that explain the results in Table 5.6.

Table 5.7: Effect of new university against Synthetic Control Group per capita in the long term

Per capital impact	**l(Total)**	**l(Local)**		**l(Neighbors)**		**l(States)**		**l(Foreign)**	
Treatment group	0.245	-0.278		0.076		0.255		0.730	*
	(0.177)	*(0.222)*		*(0.561)*		*(0.169)*		*(0.447)*	
Before_2010	-0.088	3.644	***	-0.860		0.032		0.078	
	(0.124)	*(0.141)*		*(0.306)*		*(0.113)*		*(0.288)*	
Before_1980	0.007	2.934	***	-0.539		0.098		0.029	
	(0.177)	*(0.192)*		*(0.352)*		*(0.163)*		*(0.354)*	
Before_1950	-0.109	1.600	***	-0.368		-0.113		-0.360	
	(0.206)	*(0.162)*		*(0.361)*		*(0.203)*		*(0.337)*	
Post_treatment2010	0.088	0.448	***	0.860	***	-0.032		-0.078	
	(0.124)	*(0.190)*		*(0.306)*		*(0.113)*		*(0.288)*	
Post_treatment1980	-0.069	0.421	**	0.539		-0.098		-0.029	
	(0.177)	*(0.206)*		*(0.352)*		*(0.163)*		*(0.354)*	
Post_treatment1950	0.109	0.253		0.368		0.113		0.360	
	(0.206)	*(0.156)*		*(0.361)*		*(0.203)*		*(0.337)*	
Constant	20.448	14.890	***	17.536	***	20.099	***	6.340	***
	(0.212)	*(0.234)*		*(0.581)*		*(0.180)*		*(0.269)*	
N	1388	1388		1388		1388		1388	
R-squared	0.011	0.510		0.014		0.009		0.032	

Coefficient from the difference in difference regression of per capita geographical components of distance-weighed Total GDP sum to the shock of new universities. Robust standard errors clustered by state are reported under the coefficients. *** indicates statistical significance at 1%, ** at 5% and * at 1%. *Source: own calculations.*

5.6 Conclusions

This chapter has offered an alternative methodology to explore the regional impact of local shocks from different geographical perspectives. Traditionally, academics have used spatial econometrics frameworks that require the application of tools like neighboring matrices that limit the study to small or aggregated areas. This methodology allows a more detailed analysis that ensures unbiased results by including the whole population. Traditional differences in differences regression analysis on a decomposable sum of distance-weighed GDP by county has shown that the impact of a new university affects not only the local economy, but also other counties within the state. This was already proven by Anselin et al. [1997] in the context of manufacturing industries. The analysis of the distance-weighted Total GDP reveals that the impact also affects counties in other states and improves the relative international competitiveness of the country. Using a Synthetic Control Group that replicates the initial conditions of the Treated Group proves that the effect of the shock is not spurious.

The effect of the shock dilutes with distance and time but remains significant although the time impact of the different geographical components varies, being reduced for the foreign element that obviously depends on many other factors, like its own domestic policy. The regional effect of the shock seems to take some time but is persistent in the long run, *ceteris paribus*. These results provide evidence in favor of the potential regional effect of customized local policies and prove that a holistic development policy could potentially be more effective than "spatially-blind-one-fits-all" strategies (Pike et al. [2007]; Rodríguez-Pose [2011]).

While land abundance was originally posed as a curse for Idaho Falls, the establishment of a research center transformed the production frontier of this desert area to a more valuable bundle of products that included knowledge intensive services. The previous results and this anecdotal evidence provide a lesson for both local and national authorities: economic fundamentals are by no means a restriction to the production possibility frontier; any economic configuration can provide increasing returns to scale. Perhaps, further research could help develop a model to find the factors that define the optimum industry for maximizing both the local impact and spillovers. This might require some effort from academics and policymakers, but this strategy could both reduce inequality and perpetuate the USA as the human capital paradigm.

Part III

CONCLUSION

Discussion

This thesis has shown that the service economy, in particular the knowledge intensive economy, is at the center of modern economic growth and is responsible for important income gaps at several geographical levels. The origin of the gap can be located in the establishment of a large market but the persistent snow-ball effect on growth is a consequence of the path-dependency of increasing returns. Historical economists used to depict this image as a division of the world economy into urban manufacturing towns and rural stagnating areas. More recent results reveal that the trend has become much more extreme, showing a contrast between big urban colossi consisting of large cities, and neighboring smaller cities at the service of the colossus and stagnating agricultural areas. In the case of the United States, this is very well exemplified by Moretti [2012] and his portrait of the 'two Americas'. This research agrees with the last depiction and confirms that knowledge spillovers are a cause of regional and local income gaps. However, I have shown that not everything is lost for stagnating rural American cities. This investigation has proven that attracting skilled workers contributes to long-term growth that can even expand to nearby regions and foster local and domestic prosperity. In this sense, not only local governments have a good reason to provide incentives to promote skilled employment, but national and international institutions can see this as a project for global competitiveness thanks to multiplier effects.

One of the key issues is the identification of the appropriate knowledge for each area. From these results it is clear that market size is a cause of economic growth, but that comparative advantage determines the path of a market's specialization during the first stages of development. Part of the success of the United States comes from its mineral wealth on the eve of industrialization, but the true fosterer of the leadership comes from the ability to mold the social and human capital of society at the service of this resource, as defended by Wright [1990]. Identifying what kind of knowledge can trigger the appropriate use of resources in a particular area is key to future growth. In this sense, the establishment of a Nuclear Reactor Facility full of nuclear scientists in Idaho Falls motivated the use of vast land for land intensive and knowledge intensive production. In the case of urban colossi, comparative advantage comes from large highly skilled labor markets, where the production of ideas is the cheapest option.

These results show what has happened in the United States of America, but these are not only useful for American policy-makers. The results use data on the United States but show that a local policy can trigger changes in other states and the whole nation. Therefore, also states and local authorities should find incentives to propose projects to attract skilled workers to areas within its jurisdiction by benefiting from multiplier effects. Moreover, other countries should find this information relevant to determine where local investment could stimulate economic growth; even the European Union and other cross-country associations should find this information relevant when proposing projects for structural investment funds.

Main contributions

The contributions of this research to the field of economic history are manifold. From the point of view of theoretical outcomes, it has confirmed that the service economy is much more important than economic historians have presumed, and it has revealed the necessity to study this sector in depth, particularly since the 1980s. This result is relevant for economic historians, but also for economic theorists, who might find the special nature of services as a challenge to the traditional models of development, trade and location. As a preliminary attempt, this thesis contributes by providing a mixed model of localization for services, where the size of the market is shown as the key driver of almost any industry and thus the only constraint to urbanization is the relative success of the agricultural economy. This shows that the effect of natural geography matters because it does not allow the propagation of spillovers.

This investigation has also provided several methodological improvements. First, it proves that the analysis on large geographical scales misses subtle but very relevant information on increasing returns, which are particularly crucial for the service economy. One might regard this finding as obvious: better data provide better results, but if this analysis had been done using states, the conclusions would have been much different. As explained by Krugman [1991], the smaller the industry, the greater chances of finding Increasing Returns. Analyzing the Business Service Sector at SIC 4-digit level instead of at 3-digit level would have probably lead to much more spectacular agglomeration results, but it is possible to find these increasing returns defining the geographical unit of analysis at a smaller scale too. This is relevant particularly when analyzing the role of diversification and specialization of the economic structure as it leaves room for further analysis (Bickenbach and Bode [2008]).

These contributions are backed by the creation of a new long-term data set of industrial employment by county using US Census Decennial Records that has allowed the creation of a long-term series of concentration for the 20th century that enhances the results of previous records and includes the knowledge economy.

Policy-makers can also benefit from the results obtained from these experiments. Following Fujita and Krugman [2003], I explore the effects of local knowledge shocks diffusion and show that an external (local, federal, national or international) shock can lead to long-term local growth by attracting skilled employment to a particular area. This effect spreads to nearby and distant regions, increasing the motivations of national and international policy-makers to contribute to local development.

These findings are logically outlined. Chapter 1 and Chapter 2 have provided a long-term view of the history of historical economic geography and the United States as a service economy, starting from its very first origins during the colonial era and its expansion of agricultural trade, passing through its industrialization and conversion into a world economic leader associated with the will of outstanding American entrepreneurs and willing employees. Chapter 3 performed a detailed long-term spatial analysis of industrial localization making reference to states, counties and SMSAs and showing that the service economy has progressively become the motor of the whole economy during the period. Chapter 4 develops a mixed model of localization and proves that increasing returns are the cause of localization for the aggregate economy and not only for Knowledge Intensive services. It challenges the traditional view that factor endowments define the industry of a place and shows that the only relevant factor is the one that is immobile (i.e., land). From this point of view, agricultural success has a perverse effect for the development of those regions, because it requires a small or spread local market, preventing increasing returns and externalities. Chapter 5 uses these results to produce an experiment using universities as knowledge shocks and shows optimistic results for long-term growth prospects of both rural and urban areas. The next section discusses some drawbacks of these results and presents alternative ways to apply these findings and their shortcomings.

Open gates to future research

These findings and conclusions come from the analysis of a very particular nation, the United States of America. Although this case study is purposefully used as a canonical case, and its size and multi-dimensional nature allow this, it is plausible that other conditions may lead to different conclusions for other regions. This represents, thus, an opportunity to apply these findings and methodologies to other regional scales. This is particularly relevant for regional studies as several parts of this thesis could be applied to economies in the process of integration like the European Union. There might be interesting conclusions for development policies on the local level as well.

Likewise, the research has looked at the general economy with a special focus on Knowledge Intensive Business Sectors, but there might be increasing returns in other service sectors (like Entertainment, or Finance). This analysis could also be expanded to these sectors. Additionally, this thesis calls for empirical economists to work on a model that does not only account for industry, but one that can also account for the recent and increasing trends in the service economy and transportation costs.

These findings can be criticized by those who dislike the approach of economic geography, as noted by Martin [1999]. However, both economic geographers and historical economists can find clues to modernize their approaches in these lines: by including the service economy, by avoiding the imprecise geographical unit classifications that lead to biased results, and also by adopting the simplifications derived from chapter 5.

Apart from the possible expansions and applications to other areas that can arise from these findings, it is important to address the possible shortcomings that can probably be better handled in future work. First, this text does not address that the concentration of workers can happen because of internal economies of scale rather than external economies of scale, as explained by Ellison and Glaeser

[1999]. Instead, it assumes that all the concentrations are linked by external economies of scale avoids the concentration of firms. However, the geographical concentration of workers, even if we are in a monopoly situation, must be somehow profiting from knowledge spillovers, too. In the case of Business Services the monopoly situation is far from the truth.

Additionally, the nature of external economies, and particularly knowledge spillovers has been questioned several times, not only by the mentors of these schools of thought, Jacobs and Marshall, but also by several scholars like Rosenthal and Strange [2008]. Breschi and Lissoni [2001] propose several critiques to the traditional analysis of knowledge spillovers. First, the externalities that empirical analyses on knowledge intensive sectors address are usually misclassified as knowledge spillovers, when they should be included in the other two classes of economies of agglomeration (labor market economies and specialization economies). Secondly, they expose the problem that arises thanks to the flows of tacit knowledge, that can usually be considered to be easily transmissible within local audiences, but the 'death of distance' (Venables [2001]) has allowed this knowledge to be easily dispersed within professional communities, raising some questions on the true local nature of these spillover effects. Their criticism highlights the potential jargon barrier that could prevent knowledge from flowing between different communities of technical knowledge and thus reducing the diversification effect of knowledge spillovers. They conclude that, at least recently, there is no proof that knowledge transmission occurs among people located in the same geographic area thanks to knowledge tacitness, low transaction and communication costs and labor mobility and that dis-economies of agglomeration should also be considered.

More detail can, of course improve this analysis. A potential way to polish these results could thus be to examine whether *Marshallian* or *Jacobian* externalities are behind knowledge spillovers. Including comparative data for specialized versus diversified geographical units combined with the growth patterns of population could explain the R&D divergence between growing (hypothetically diverse) cities and stagnating ones.

Part IV

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Part V

Appendices

Appendix

A Data collection: building the longitudinal panel data

- 1890 Data: The 11th Census of Population and Housing provides data on manufacturing workers (by skill level or occupation) and number of teachers in schools. The data of agricultural workers was obtained from Craig and Weiss [1998]. Ultimately, the data for this benchmark year includes only three categories of occupations per county whereas the rest of the benchmark years include more than 10 categories. An alternative to this lack of information is to use the classification of skilled manufacturing employees (those that lead with managerial occupations) as a proxy for the knowledge intensive sector. However, the accuracy of this estimation is dubious. Consequently, the data for this year are used for comparative purpose only and are not included in calculations to avoid biased results.

- 1930 Data are very detailed by occupation in original censuses. However, the occupation classification used by the US Census report made industry estimations complicated. From this report, the Inter-university Consortium for Political and Social Research (ICPSR) collected the data using a classification that is more convenient for the purpose of this investigation than the original one. However, certain collection problems are difficult to solve: according to the procedural file provided by the US Census, enumerators generated a bias by counting housewives as domestic workers included in the labor force, showing that domestic service workers seem to be almost proportionally allocated across the country. The data for 1950 and 2010 ignore this sector, and a process of estimation is not considered as it involves a big time investment that cannot be paired with good long-term results. Instead, these observations will be taken with caution when used.

- 1950 Data were collected directly from the 17^{th} Housing and Population census records. Although industry and class of worker was collected on a 100-percent basis, questions related to industry were asked for a sample of one out of every 30 persons and first tabulations revealed a very large "not reported" rate. Moreover, occupation classification was very detailed, but the 1950 Census industrial classification system was organized into 13 groups. As a consequence, private household services where omitted. These data have been converted to the classification used in this research by using the most accurate data and the extrapolations from other years.

- 1980 Data were collected from both US Census Population and Housing data records by industry and ICPSR. Census data are more detailed than the data provided by the Summary File provided by ICPSR. However, some state booklets were not available and ICPSR compilations were used instead. The Census report omits data on agricultural workers. Therefore, the USDA - Census of Agriculture Historical Archive were used to obtain data from agricultural employees (farmers and others). However, Census of Agriculture data are only published every five years, thus, data provided do not match perfectly with the timing of decennial employment data. Under the assumption that the agricultural sector is stable and moves slowly, it is assumed that a three-year gap will not cause big deviations.

- 2010 Data on employment on each industrial division have been obtained from the County Business Patterns. This database uses the 2007 NAICS classification, up to six levels, but the data have been aggregated to match the 1980 classification. The US Census grants privacy to respondents by showing inaccuracies whenever a single firm operates an industry in a specific region (county, state or nation) by stating an interval instead of the real value. The approximate number of employees has been estimated through the records of number of firms within each size class, also available from the US Census. Moreover, the USDA Census of Agriculture Historical Archive has been used to obtain data omitted from the County Business Patterns (farmers and others within categories 111 and 112). However, Census of Agriculture data are only published every five years while data on the census are published every ten years (in this case, the last publication of the Census of Agriculture corresponds to 2007 and CBP corresponds to year 2010) but the assumption that abrupt changes do not occur in the agricultural sector allows the use of these data as an approximation in this case as well.

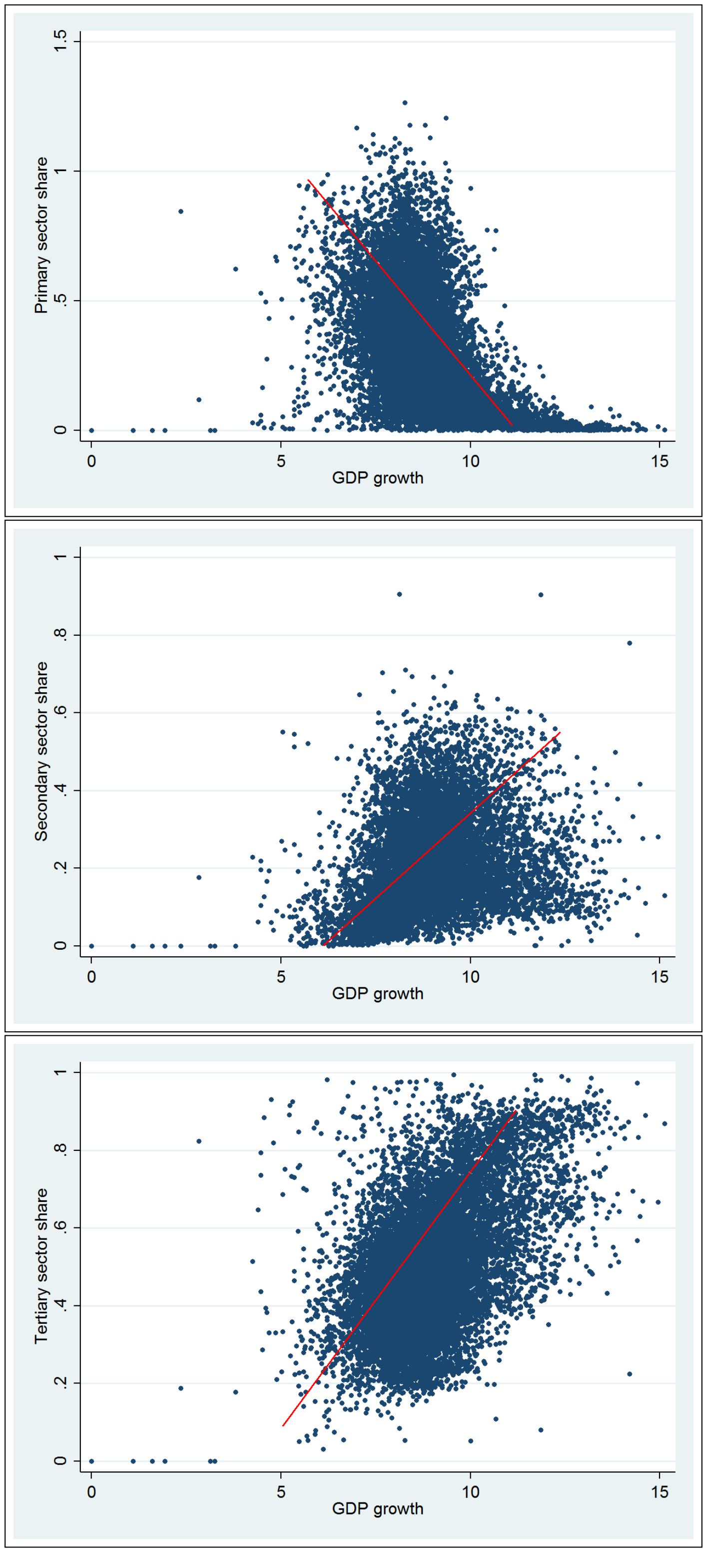
B Industry and structural change

Table 8: Employment structures in the Netherlands, UK and USA - 1700 to 2010 (% of total employment)

Year	Sector	NL	UK	USA
1700	Primary	40	56	n.a.
	Secondary	33	22	n.a.
	Tertiary	27	22	n.a.
1820	Primary	n.a.	40	n.a.
	Secondary	n.a.	32	n.a.
	Tertiary	n.a.	28	n.a.
1890	Primary	33	16	39
	Secondary	31	44	27
	Tertiary	36	40	34
1989	Primary	5	2	3
	Secondary	26	29	26
	Tertiary	69	69	71
2010	Primary	3	1	2
	Secondary	15	19	17
	Tertiary	82	80	81

Source: Maddison [2010] estimations and ILO (2010).

Figure 4: Correlation between sector share and GDP growth by county



Source: own calculations from US Census data.

Table 9: Forward and backward industrial linkages measured with correlations

	Agriculture	FoFi	Mining	Food Kindred	Publishing	Chemical	Primary metal	Furniture	Fabricated metal	Machinery	Transport equip	Railroads	Trucking	Other transp
Agriculture		-0.077	-0.104	0.086	-0.186	-0.199	-0.184	-0.160	-0.210	-0.134	-0.211	-0.002	0.015	-0.223
FoFi	-0.077		-0.014	0.036	-0.131	-0.062	-0.019	0.270	-0.144	-0.153	-0.070	0.049	-0.141	0.175
Mining	-0.104	-0.014		-0.196	-0.179	-0.060	-0.005	-0.102	-0.143	-0.160	-0.143	0.025	0.076	0.017
Food & Kindred	0.086	0.036	-0.196		0.038	-0.021	-0.032	-0.029	0.045	0.054	-0.021	-0.045	0.095	-0.074
Printing & publishing	-0.186	-0.131	-0.179	0.038		0.069	0.041	-0.154	0.202	0.187	0.095	-0.021	0.077	0.092
Chemical	-0.199	-0.062	-0.060	-0.021	0.069		0.043	-0.042	0.107	0.047	0.075	-0.015	0.027	0.063
Primary metal	-0.184	-0.019	-0.005	-0.032	0.041	0.043		-0.026	0.185	0.091	0.080	0.021	0.022	0.074
Furniture	-0.160	0.273	-0.102	-0.029	-0.154	-0.042	-0.026		-0.023	-0.106	-0.066	-0.049	-0.022	-0.096
Fabricated metal	-0.210	-0.144	-0.143	0.045	0.202	0.107	0.185	-0.023		0.282	0.227	-0.037	0.113	-0.067
Machinery	-0.134	-0.153	-0.160	0.054	0.187	0.047	0.091	-0.106	0.282		0.180	0.000	0.035	-0.100
Transp equip	-0.211	-0.078	-0.143	-0.021	0.095	0.075	0.080	-0.066	0.227	0.180		-0.034	0.014	0.038
Railroads	-0.002	0.049	0.025	-0.045	-0.021	-0.015	0.021	-0.049	-0.037	0.000	-0.034		-0.014	-0.042
Trucking & warehousing	0.015	-0.141	0.076	0.095	0.077	0.027	0.022	-0.022	0.113	0.035	0.014	-0.014		0.007
Other transp	-0.223	0.175	0.017	-0.074	0.092	0.063	0.074	-0.096	-0.067	-0.100	0.038	-0.042	0.007	
Communications	-0.040	-0.004	0.110	-0.060	-0.066	0.065	0.057	-0.036	-0.013	-0.093	-0.062	-0.005	-0.007	0.011
Utilities	-0.360	-0.034	0.014	-0.099	0.178	0.030	0.028	-0.149	0.029	-0.020	0.004	-0.009	0.002	0.194
Wholesale	0.128	-0.143	-0.165	0.185	0.151	-0.006	-0.069	-0.220	0.031	0.026	-0.005	-0.069	0.214	0.036
Retail	-0.426	-0.133	-0.072	0.005	0.205	0.097	0.103	-0.138	0.140	0.086	0.109	-0.022	0.057	0.185
Food stores	0.001	0.008	0.000	-0.072	-0.138	-0.033	-0.024	-0.018	-0.048	-0.070	-0.043	0.086	-0.086	-0.069
Banking	-0.130	-0.150	-0.077	-0.007	0.246	0.013	0.005	-0.185	0.046	0.008	0.054	-0.028	0.055	0.180
Insurance	-0.357	-0.062	-0.169	-0.052	0.312	0.037	-0.006	-0.210	0.069	0.058	0.078	-0.069	-0.007	0.287
Business services	-0.378	-0.072	-0.080	-0.057	0.230	0.104	0.007	-0.176	0.043	0.016	0.070	-0.077	-0.058	0.255
Health	0.085	-0.141	-0.160	0.081	0.172	-0.054	-0.004	-0.114	0.104	0.138	0.020	-0.042	0.074	-0.065
Elementary education	-0.077	0.049	-0.024	-0.081	0.012	-0.056	-0.041	-0.058	-0.106	-0.088	-0.080	-0.080	-0.152	0.032
Other education	-0.006	0.011	-0.001	-0.019	0.044	-0.055	-0.036	-0.027	-0.037	-0.017	-0.032	0.002	-0.057	0.041
Entertainment	-0.227	0.020	-0.051	-0.083	0.122	-0.016	-0.014	-0.111	-0.024	-0.008	0.001	-0.043	-0.127	0.120
Hospitals	-0.234	-0.103	-0.069	-0.025	0.106	0.047	0.028	-0.116	0.032	0.053	0.033	-0.030	-0.027	0.042
Professional services	-0.351	0.027	-0.056	-0.079	0.236	0.007	0.016	-0.173	-0.032	-0.033	0.033	-0.082	-0.115	0.316

	Communications	Utilities	Wholesale	Retail	Food stores	Banking	Insurance	Business Serv	Health	Elem educ	Other educ	Entertainment	Hospitals	Professionals
Agriculture	-0.040	-0.360	0.128	-0.426	0.001	-0.130	-0.357	-0.378	0.085	-0.077	-0.006	-0.227	-0.234	-0.351
FoFi	-0.004	-0.034	-0.143	-0.133	0.008	-0.150	-0.062	-0.072	-0.141	0.049	0.011	0.020	-0.103	0.027
Mining	0.110	0.014	-0.165	-0.072	0.000	-0.077	-0.169	-0.080	-0.160	-0.024	-0.001	-0.051	-0.069	-0.056
Food & Kindred	-0.060	-0.099	0.185	0.005	-0.072	-0.007	-0.052	-0.057	0.081	-0.081	-0.019	-0.083	-0.025	-0.079
Printing & publishing	-0.066	0.178	0.151	0.205	-0.138	0.246	0.312	0.230	0.172	0.012	0.044	0.122	0.106	0.236
Chemical	0.065	0.030	-0.006	0.097	-0.033	0.013	0.037	0.104	-0.054	-0.056	-0.055	-0.016	0.047	0.007
Primary metal	0.057	0.028	-0.069	0.103	-0.024	0.005	-0.006	0.007	-0.004	-0.041	-0.036	-0.014	0.028	0.016
Furniture	-0.036	-0.149	-0.220	-0.138	-0.018	-0.185	-0.210	-0.176	-0.114	-0.058	-0.027	-0.111	-0.116	-0.173
Fabricated metal	-0.013	0.029	0.031	0.140	-0.048	0.046	0.069	0.043	0.104	-0.106	-0.037	-0.024	0.032	-0.032
Machinery	-0.093	-0.020	0.026	0.086	-0.070	0.008	0.058	0.016	0.138	-0.088	-0.017	-0.008	0.053	-0.033
Transp equip	-0.062	0.004	-0.005	0.109	-0.043	0.054	0.078	0.070	0.020	-0.080	-0.032	0.001	0.033	0.033
Railroads	-0.005	-0.009	-0.069	-0.022	0.086	-0.028	-0.069	-0.077	-0.042	-0.080	0.002	-0.043	-0.030	-0.082
Trucking & warehousing	-0.007	0.002	0.214	0.057	-0.086	0.055	-0.007	-0.058	0.074	-0.152	-0.057	-0.127	-0.027	-0.115
Other transp	0.011	0.194	0.036	0.185	-0.069	0.180	0.287	0.255	-0.065	0.032	0.041	0.120	0.042	0.316
Communications		-0.038	-0.086	-0.044	-0.019	-0.025	-0.082	-0.039	-0.052	-0.073	-0.018	-0.063	-0.030	-0.078
Utilities	-0.038		0.130	0.342	-0.128	0.299	0.434	0.379	0.033	0.029	0.073	0.239	0.156	0.395
Wholesale	-0.086	0.130		0.142	-0.121	0.303	0.227	0.111	0.207	-0.129	-0.051	-0.044	0.030	0.104
Retail	-0.044	0.342	0.142		-0.156	0.253	0.353	0.333	0.066	0.066	0.017	0.146	0.235	0.279
Food stores	-0.019	-0.128	-0.121	-0.156		-0.162	-0.166	-0.134	-0.126	-0.163	-0.059	-0.103	-0.135	-0.145
Banking	-0.025	0.299	0.303	0.253	-0.162		0.438	0.303	0.206	-0.097	0.042	0.139	0.166	0.338
Insurance	-0.082	0.434	0.227	0.353	-0.166	0.438		**0.525**	0.132	-0.015	0.053	0.360	0.191	**0.564**
Business services	-0.039	0.379	0.111	0.333	-0.134	0.303	**0.525**		-0.023	0.033	0.082	0.271	0.126	**0.559**
Health	-0.052	0.033	0.207	0.066	-0.126	0.206	0.132	-0.023		-0.011	0.080	-0.009	0.229	0.024
Elementary education	-0.073	0.029	-0.129	0.066	-0.163	-0.097	-0.015	0.033	-0.011		0.138	0.030	0.060	0.065
Other education	-0.018	0.073	-0.051	0.017	-0.059	0.042	0.053	0.082	0.080	0.138		0.096	0.046	0.121
Entertainment	-0.063	0.239	-0.044	0.146	-0.103	0.139	0.360	0.271	-0.009	0.030	0.096		0.060	0.335
Hospitals	-0.030	0.156	0.030	0.235	-0.135	0.166	0.191	0.126	0.229	0.060	0.046	0.060		0.147
Professional services	-0.078	0.395	0.104	0.279	-0.145	0.338	**0.564**	**0.559**	0.024	0.065	0.121	0.335	0.147	

Source: own calculations using industrial data by county from the year 1980 from the US Census.

C Geographical versus industrial inequality

It is crucial to understand how specialization and concentration determine each other. Under a perfectly even allocation of resources, there would be no incentives for specialization or concentration, each location would produce the same goods proportionally. From Krugman [1991], it can be inferred that at zero transportation cost, that would also be the case. In the real world, however there are both costs of transaction and transportation and differences in the regional distribution of factors of production. As explained by Bickenbach and Bode [2008], both (industrial) specialization and (geographical) concentration account for the disproportion of a distribution of workers/firms across a set of exclusive categories. It is crucial to understand that using the same data, these indicators are fundamentally different: specialization measures the disproportion of workers allocated by industry holding regions constant while a variable measuring concentration considers regions and keeps the industry constant.

Formally, a regional concentration measure for finite sets of industries

$$i \in I\{1, ..., I\} \tag{3}$$

and regions

$$r \in R\{1, ..., R\} \tag{4}$$

let

$$L_{ir} = L_{ir} : ir \in \{IxR\} \tag{5}$$

denote the employment pattern by industry and region,

$$L_{ir} = L_{ir} : r \in \{R\} \tag{6}$$

the distribution of an industry (i) employment across regions. For a given employment distribution,

$$\Pi_r = \Pi_r : r \in \{R\} \tag{7}$$

and region-specific weights,

$$W_r = W_r : r \in \{R\} \tag{8}$$

the dis-proportionality measure is given by

$$\mathtt{RegionalConcentration}_i^{W\Pi} = f_m\left[W_r, \frac{L_{i(r)}}{\Pi_r}\right] \tag{9}$$

Where the RC measure reflects a function such that region-specific proportionality factors are scaled by their weights, for example, the Locational Gini Coefficient. These indicators do not describe inequality across regions, but inequality across proportions.

Similarly, an industrial specialization measure for finite sets of industries

$$i \in \{I\}\{1, ..., I\} \tag{10}$$

and regions

$$r \in \{R\}\{1, ..., R\} \tag{11}$$

let

$$L_{ir} = L_{ir} : ir \in \{IxR\} \tag{12}$$

denote the employment pattern by industry and region,

$$L_{r(i)} = L_{ri} : i \in \{1, ..., R\} \tag{13}$$

the distribution of employment in region (r) across industries. For a given employment distribution,

$$\Pi_i = \Pi_i : i \in \{1, ..., R\} \tag{14}$$

and industry-specific weights,

$$W_i = W_i :\in \{1, ..., R\} \tag{15}$$

the dis-proportionality measure is given by

$$\mathtt{IndustrialSpecialization}_r^{W\Pi} = f_m\left[W_i, \frac{L_{r(i)}}{\Pi_i}\right] \tag{16}$$

In this function industry-specific proportionality factors are scaled by their weights such that the index describes inequality across industry proportions.

In this sense, we can argue that specialization and concentration indicators measure different dimensions of the same observation. Thus they move together Kim [1995], but not necessarily in the same direction, as shown by Aiginger and Davies [2004]. As usual, these relationships are better understood by looking at extreme cases: say two economies are completely specialized in different industries, as in Ricardo's example, each industry must be completely concentrated within each economy. Conversely, a perfectly proportional distribution (no concentration at all) would imply no specialization, i.e. no trade in an economy full of many Robinsons that provide for themselves. These indexes show a half-blind portrait of the distribution of employment. To solve this dichotomy, Hoover's Index of Localization (1935) manages to show both magnitudes in a single indicator:

$$L_{ir} = \frac{\frac{E_{ir}}{E_i}}{\frac{E_r}{E}} \tag{17}$$

Where, E_{ir} is total employment in industry *i* for region *r*, E_i is total employment for industry *i* for the total of the country, E_r is the total of employment in region *j*, and E the total employed on the country. This index measures whether the proportion of workers of an industry in a region is proportional to the participation of that area in the overall production of the country. Note that while industrial specialization indicators lay one indicator per region and concentration indicators (such as the Locational Gini Index used in this investigation) give one observation per industry, Hoover's localization index shows an observation per region and industry (I x R) which makes this variable much more complete but more complicated to understand without visual aid.

D Accounting for smaller geographical units

Table 10: Locational Gini indexes by state and county, 1980

Sector	Industry	State	County
Primary	Agriculture	0.169	0.306
	Forestry and fishing	0.267	0.387
	Mining	0.313	0.395
Secondary	Construction	0.092	0.112
	Food and kindred products	0.106	0.197
	Textiles	0.279	0.338
	Printing and publishing	0.107	0.149
	Chemical	0.153	0.265
	Furniture and lumber	0.198	0.297
	Primary metal industry	0.400	0.316
	Fabricated metal industry	0.155	0.209
	Machinery (except electrical)	0.199	0.237
	Electrical machinery	0.133	0.261
	Transportation equipment	0.208	0.295
Tertiary	Railroads	0.147	0.261
	Trucking and warehousing	0.068	0.117
	Other transportation	0.108	0.160
	Communications	0.088	0.141
	Utilities and sanitary services	0.063	0.123
	Wholesale trade	0.051	0.095
	General merchandise	0.039	0.087
	Food and bakery stores	0.038	0.090
	Automotive and gas dealers	0.118	0.061
	Eating and drinking	0.052	0.074
	Repair services	0.062	0.079
	Private households	0.102	0.152
	Other personal services	0.069	0.101
	Health services	0.060	0.081
	Hospitals	0.052	0.103
	Elementary education	0.039	0.092
	Other education	0.085	0.058
	Social services	0.042	0.076
	Entertainment	0.121	0.165
	Banking and credit agencies	0.058	0.090
	Insurance and Real Estate	0.080	0.130
	Business services	0.099	0.153
	Professional services	0.088	0.139
	Public administration	0.083	0.146

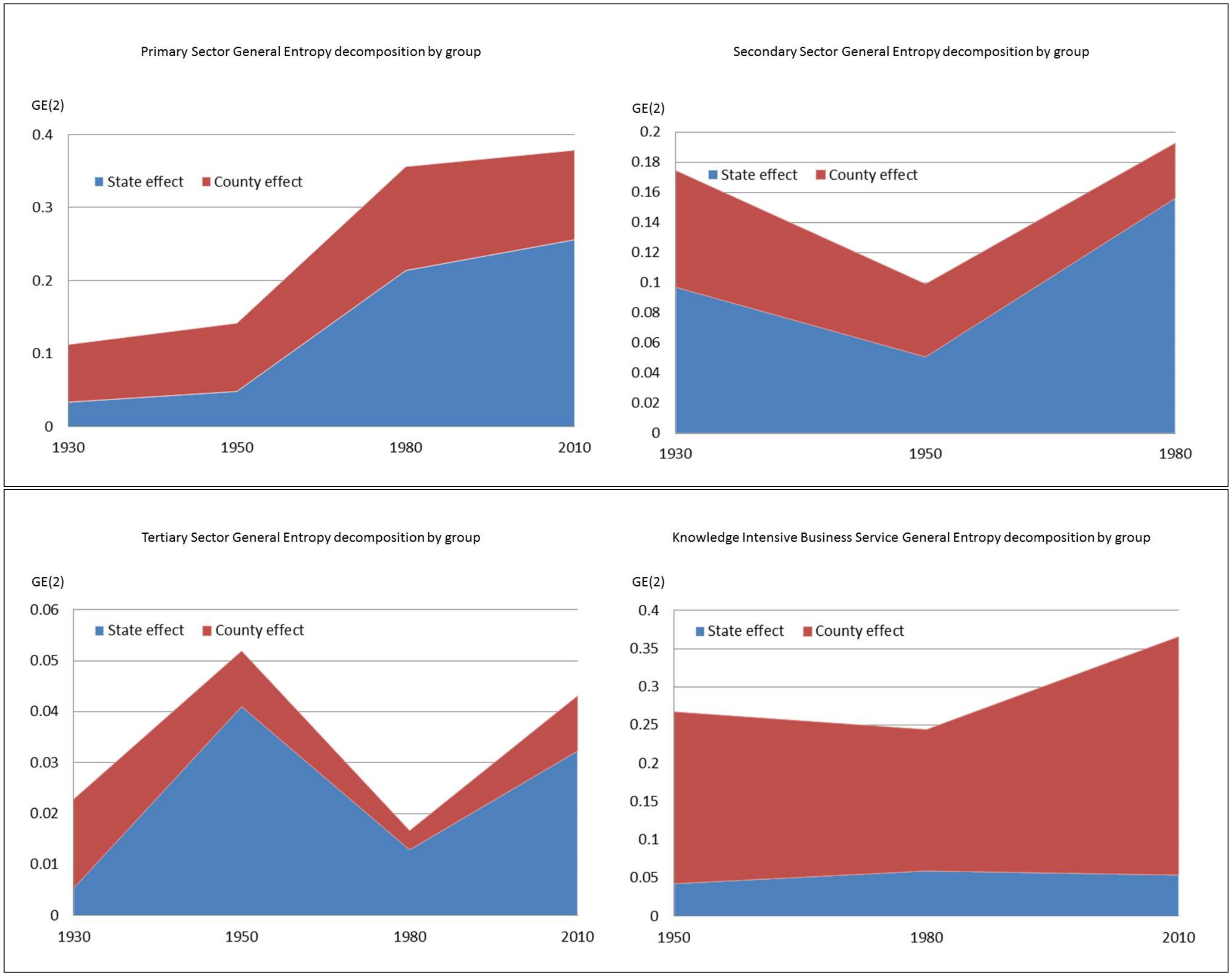
Source: own calculations from US Census data.

Table 11: Between and within state inequality on employment 1980.

	GE(2)					County effect					State effect				
	1890	1930	1950	1980	2010	1890	1930	1950	1980	2010	1890	1930	1950	1980	2010
Primary Sector	-	**0.112**	**0.142**	**0.356**	**0.379**	-	**0.702**	**0.659**	**0.400**	**0.324**	-	**0.298**	**0.341**	**0.600**	**0.676**
Agriculture	67.447	0.129	0.181	0.522	0.420	0.950	0.692	0.648	0.554	0.680	0.050	0.308	0.352	0.446	0.320
Forestry & fisheries	-	0.898	5.503	3.748	6.167	-	0.000	0.838	0.757	0.882	-	1.001	0.162	0.243	0.118
Mining	-	0.960	3.183	2.010	3.186	-	0.012	0.808	0.718	0.817	-	0.988	0.192	0.282	0.183
Secondary Sector	-	-	**0.174**	**0.099**	**0.193**	-	-	**0.444**	**0.488**	**0.190**	-	-	**0.556**	**0.512**	**0.810**
Construction	-	-	0.111	0.099	0.226	-	-	0.809	0.812	0.885	-	-	0.191	0.188	0.114
Manufacturing	1.270	0.973	0.350	0.194	0.334	0.666	0.844	0.543	0.495	0.801	0.334	0.156	0.457	0.505	0.199
Tertiary Sector	-	0.023	0.052	0.017	0.043	-	0.764	0.210	0.225	0.251	-	0.236	0.790	0.775	0.749
Utilities & comms.	-	-	0.535	0.139	2.114	-	-	0.871	0.906	0.947	-	-	0.129	0.094	0.053
Trade	-	0.217	0.052	0.103	0.053	-	0.822	0.784	0.546	0.890	-	0.178	0.216	0.454	0.109
Personal services	-	-	0.066	0.031	0.069	-	-	0.884	0.776	0.812	-	-	0.115	0.224	0.188
Repair services	-	-	*0.087*	*0.094*	*0.358*	-	-	*0.726*	*0.216*	*0.956*	-	-	*0.274*	*0.216*	*0.044*
Private households	-	-	*0.280*	*0.310*	-	-	-	*0.576*	*0.662*	-	-	-	*0.424*	*0.338*	-
Entertainment	-	-	-	0.561	1.617	-	-	-	0.746	0.907	-	-	-	0.254	0.093
Social Services	-	-	-	*0.088*	*0.188*	-	-	-	*0.767*	*0.872*	-	-	-	*0.233*	*0.104*
Health Services	-	-	*0.487*	*0.108*	*0.142*	-	-	*0.895*	*0.711*	*0.089*	-	-	*0.105*	*0.289*	*0.108*
Education	-	-	*0.155*	*0.010*	*2.790*	-	-	*0.895*	*0.920*	*0.921*	-	-	*0.105*	*0.079*	*0.079*
Elementary	0.190	-	0.155	0.102	3.290	0.486	-	0.896	0.922	0.055	0.487	-	0.105	0.078	0.945
Other education	-	-	-	0.277	7.230	-	-	-	0.935	0.971	-	-	-	0.065	0.029
Other services	-	-	*0.139*	-	*0.097*	-	-	*0.708*	-	*0.880*	-	-	*0.292*	-	*0.120*
FIRE	-	-	**0.226**	**0.105**	**0.194**	-	-	**0.805**	**0.816**	**0.954**	-	-	**0.195**	**0.184**	**0.046**
Insurance & Real Estate	-	-	-	*0.212*	-	-	-	-	*0.936*	-	-	-	-	*0.064*	-
Insurance	-	-	-	-	*0.314*	-	-	-	-	*0.923*	-	-	-	-	*0.077*
Real Estate	-	-	-	-	*0.515*	-	-	-	-	*0.862*	-	-	-	-	*0.138*
Finance and Banking	-	-	-	*0.075*	*0.995*	-	-	-	*0.873*	*0.950*	-	-	-	*0.127*	*0.050*
KIBS	-	-	**0.267**	**0.244**	**0.366**	-	-	**0.842**	**0.757**	**0.852**	-	-	**0.160**	**0.243**	**0.148**
Business services	-	-	*0.751*	*0.456*	*0.480*	-	-	*0.851*	*0.858*	*0.889*	-	-	*0.149*	*0.142*	*0.112*
Professional services	-	*0.024*	*0.290*	*0.261*	*0.541*	-	*0.001*	*0.864*	*0.617*	*0.856*	-	*0.999*	*0.136*	*0.383*	*0.144*
Public Administration	-	0.069	0.457	0.235	0.275	-	0.004	0.752	0.762	0.852	-	0.996	0.248	0.238	0.148

Source: own calculations from US Census data.

Figure 5: GE(2) geographical group decomposition by industry

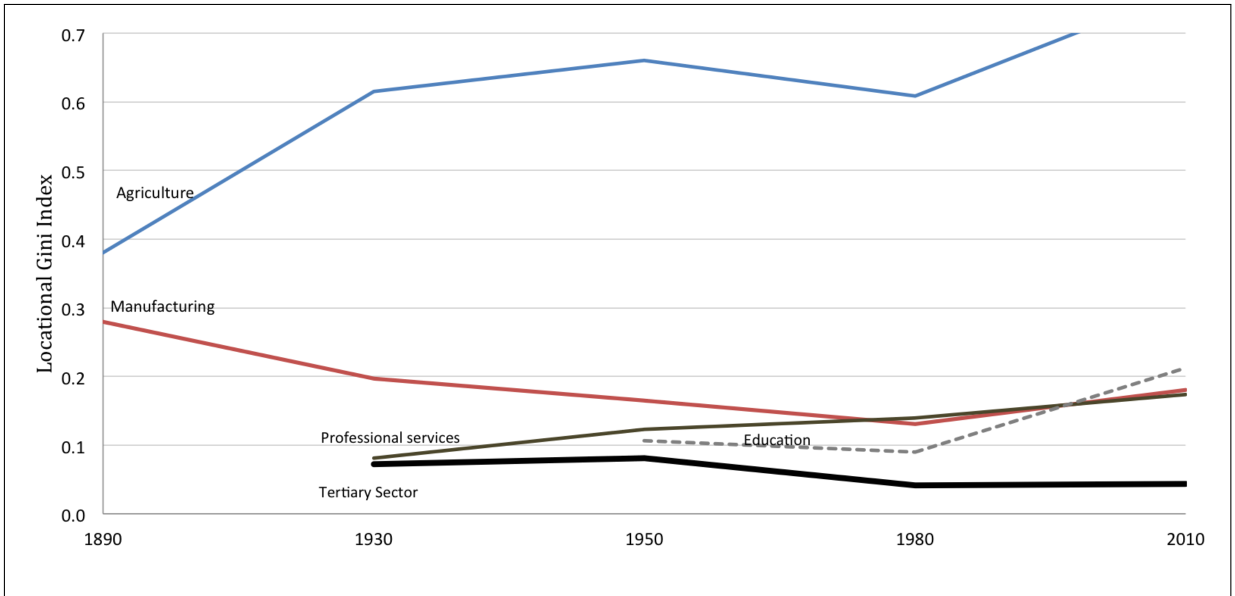


Source: own calculations from US Census data.

E Location coefficients (HLI)

Location indexes are derived as the relative share of employment devoted to a sector in a specific county, relative to the contribution of that sector in the national economy. It represents each of the points in the Locational Lorenz Curve, as in Krugman [1991]. The following graph shows the long term pattern of geographical concentration on the employment records of sectors and several sub-sectors using counties as a unit of analysis. In accordance with Desmet and Fafchamps [2006]'s results, knowledge Intensive sectors are surpassing the agglomeration records of manufacturing since the 1980s.

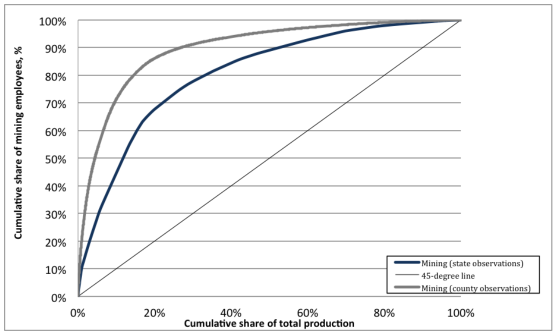
Figure 6: Long-term Locational Gini coefficients



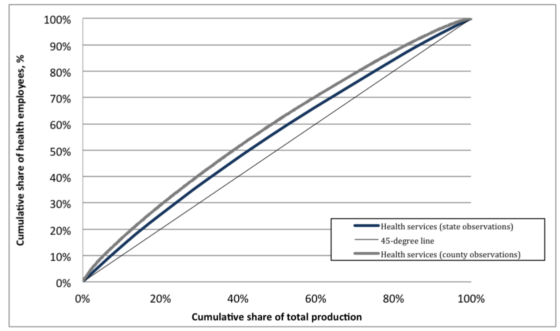
Source: own calculations from US Census data.

These Locational Gini coefficients come from the area between the analogue Locational Lorenz Curve and the perfect proportion line (situation in which a sector's employees are allocated in proportion to population given the national share of that sector). Figure 7 illustrates the case of mining and business services for the year 1980 and show that the mining sector is much more unequal than business services by county in the whole territory of the US: this means that most of the counties do not have or have very a low participation rate of employment in the business service economy. There are many counties that have a high share of employment devoted to mining and many that have none.

Figure 7: Lorenz Curves, 1980



(a) MINING

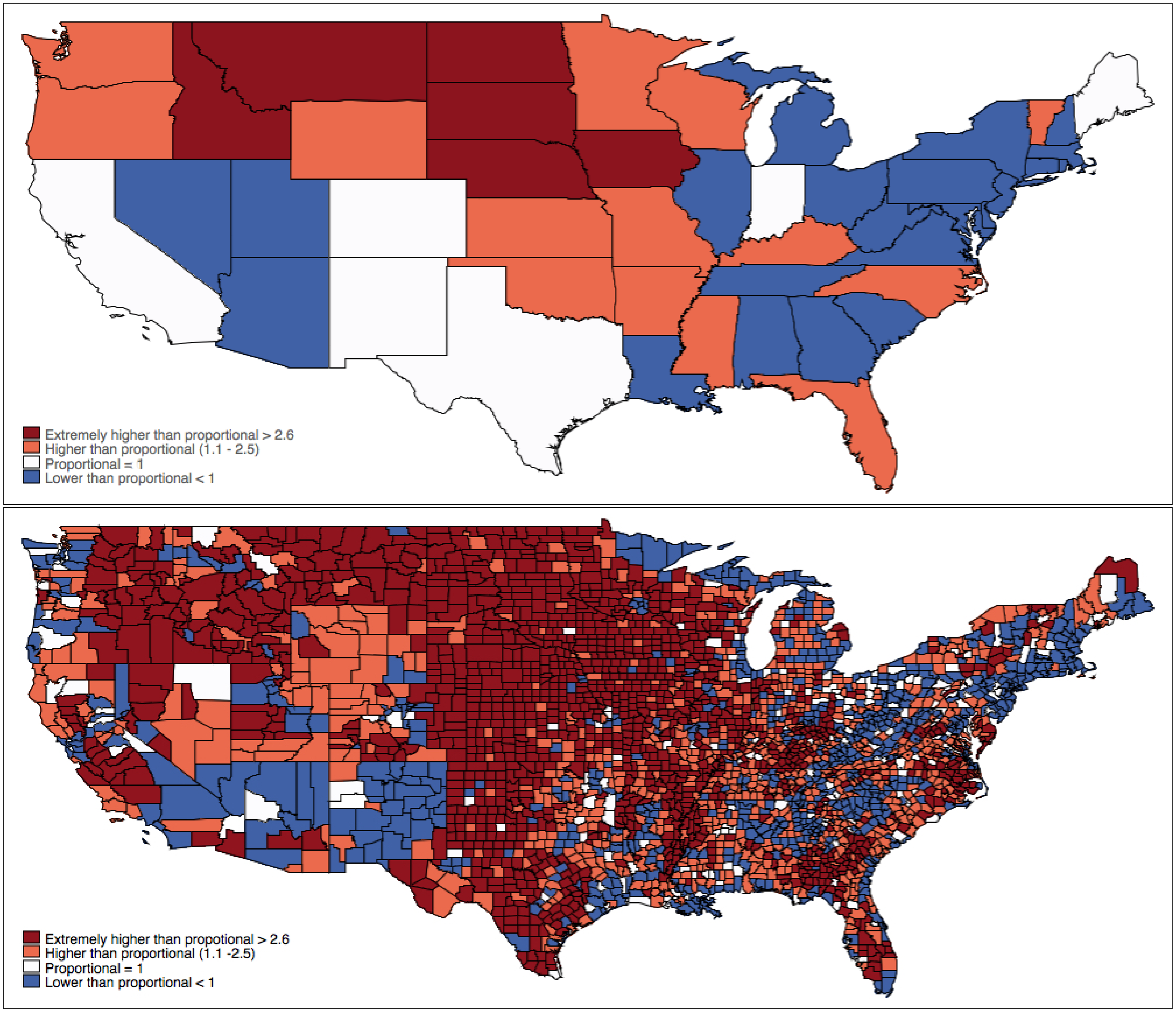


(b) HEALTH

Source: own calculations from US Census data.

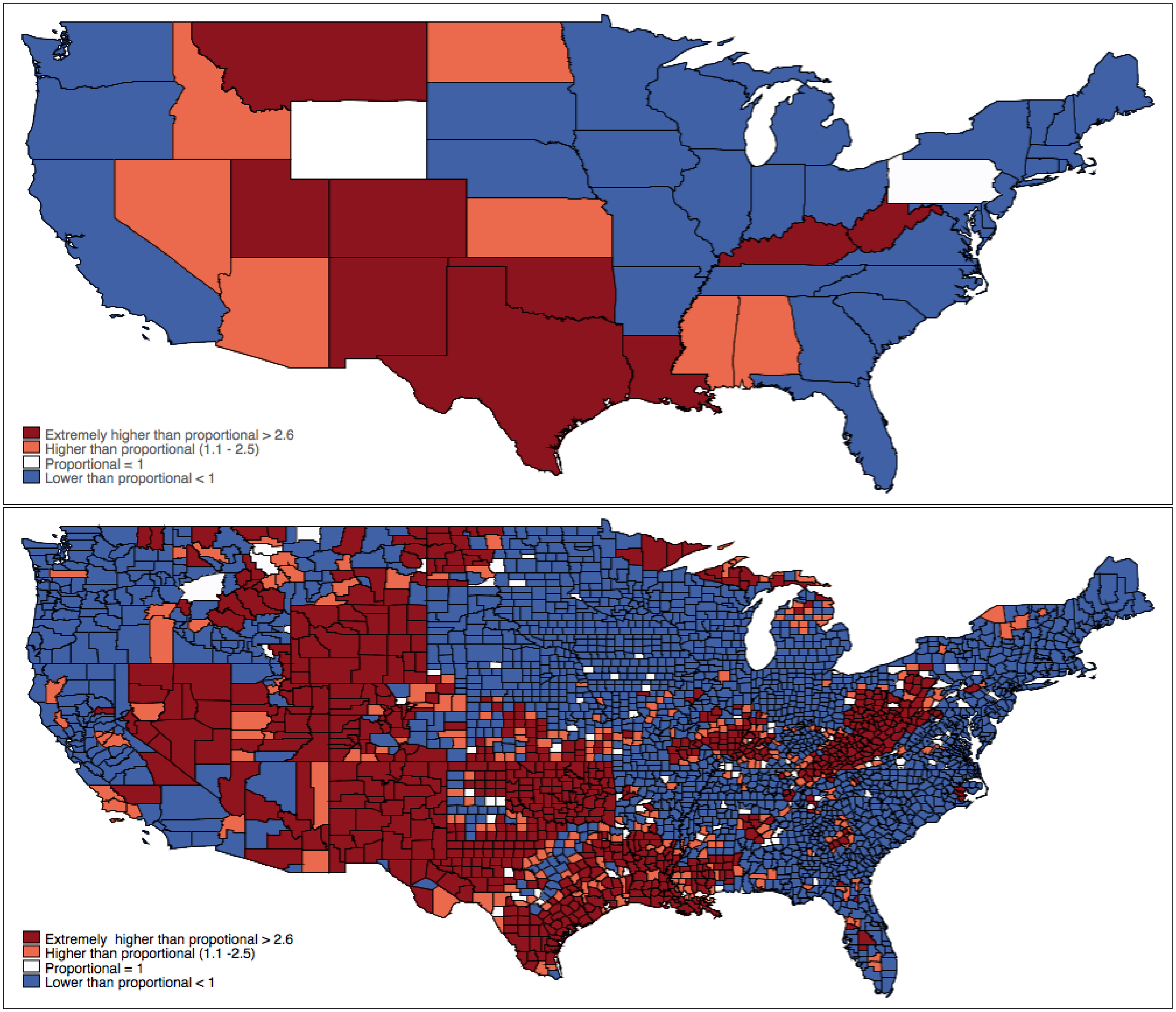
An alternative way to present this information is by taking each of the points in the Lorenz Curve, which is the share of the sector's employment in each county relative to the national share, and plotting them on a choropleth map. Figure 8 describes the observations from the agricultural sector for 1980, where most counties in the centre of the country show an extremely higher than proportional share of agricultural employment relative to the national values. Figure 18 shows the observations for location coefficients for KIBS in the years 1950 and 1980, used as an independent variable in several regressions of this study. Both figures show that a few counties account for most of the Business Service employment while the rest buy services from them.

Figure 8: Location coefficients by state and county - Agriculture, 1980



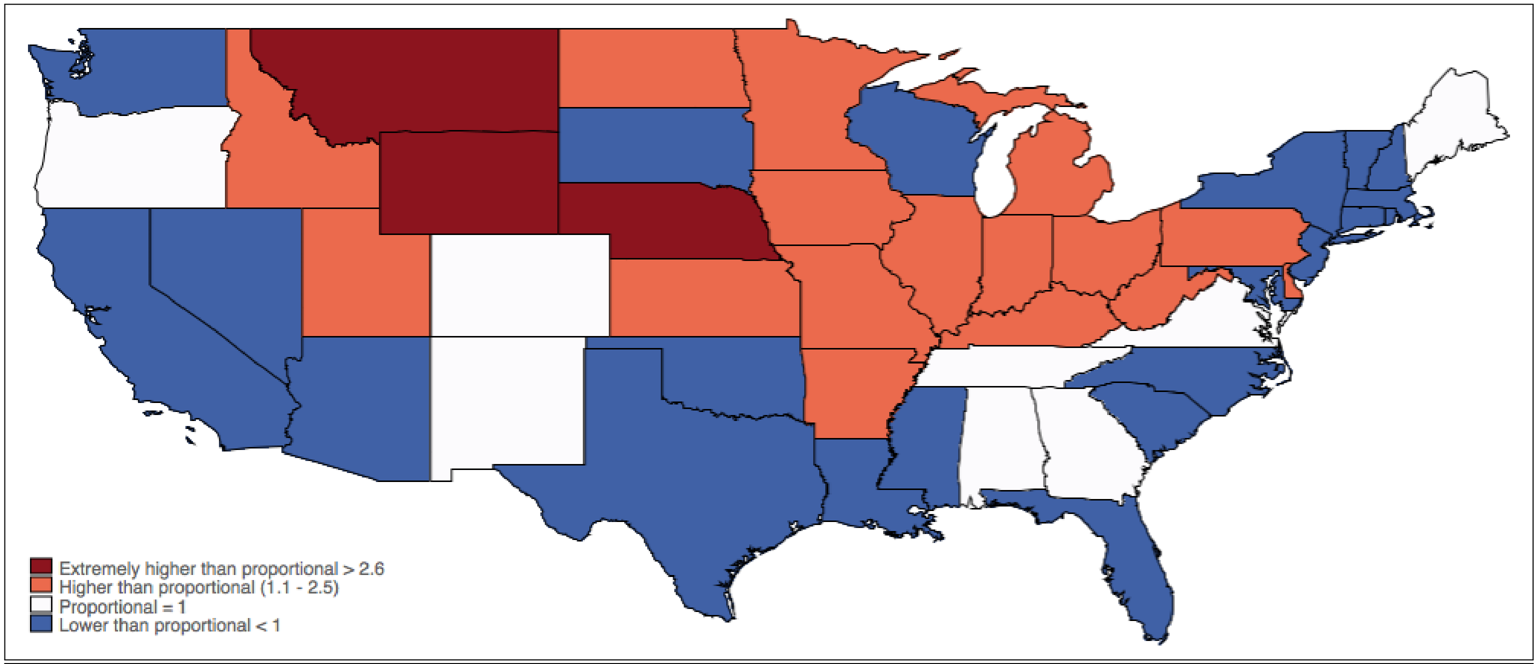
Source: own calculations from US Census of Agriculture data.

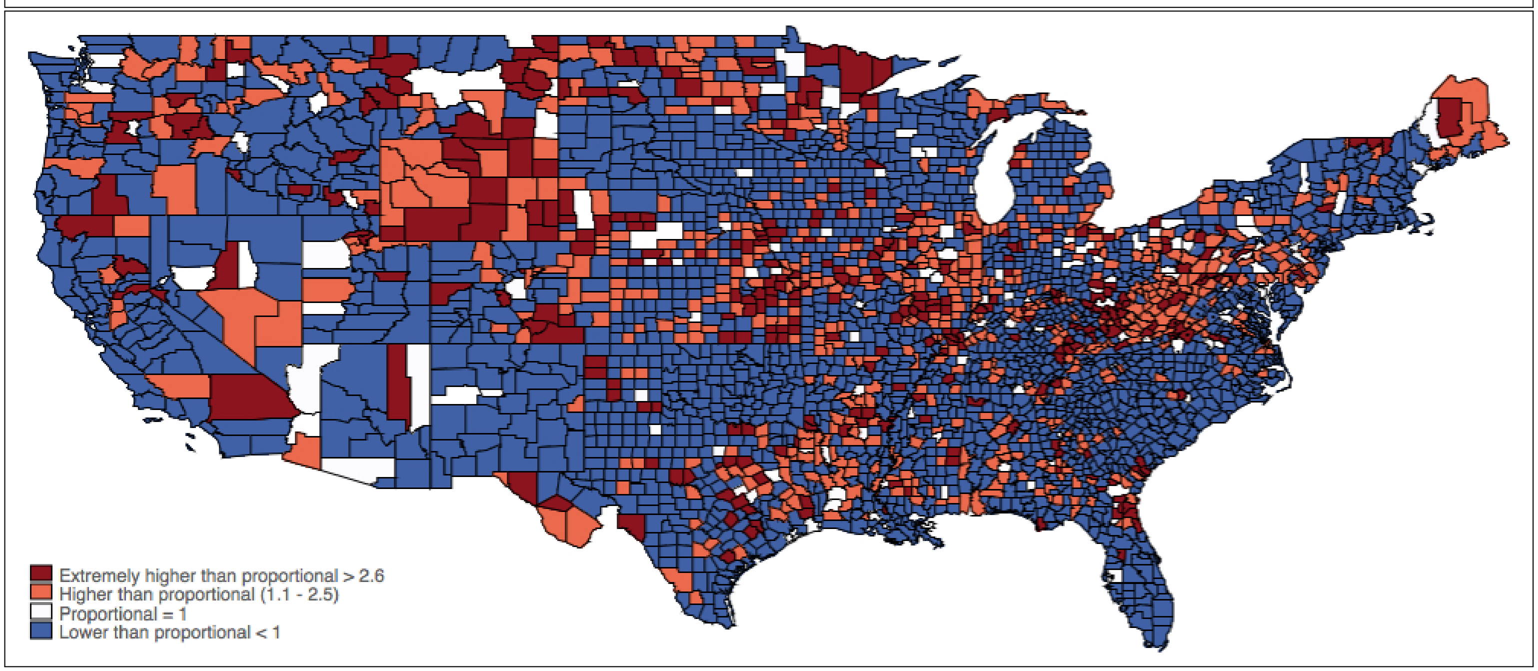
Figure 9: Location coefficients by state and county - Mining, 1980



Source: own calculations from US Census data.

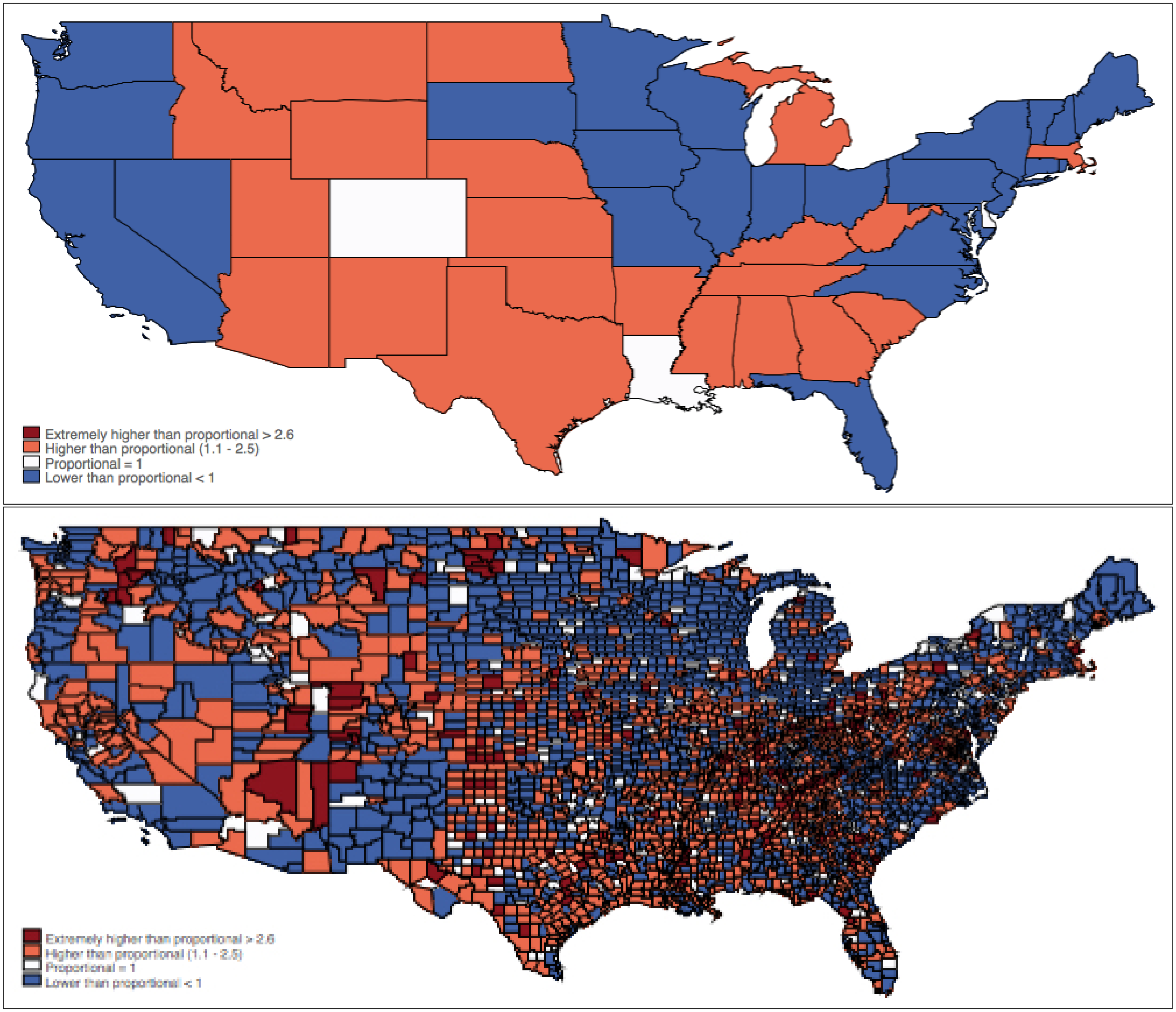
Figure 10: Location coefficients by state and county - Railroads, 1980





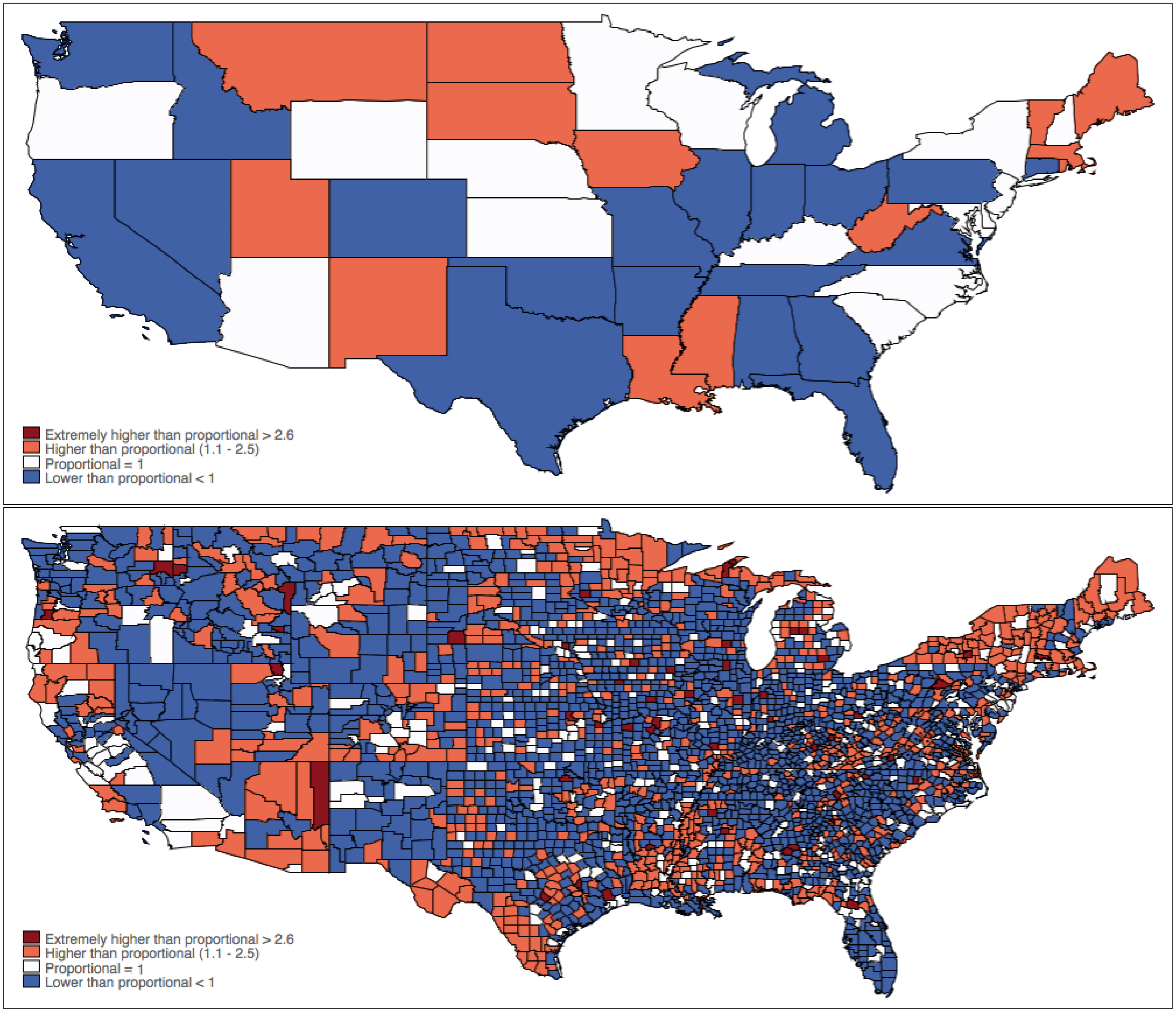
Source: own calculations from US Census data.

Figure 11: Location coefficients by state and county - Utilities, 1980



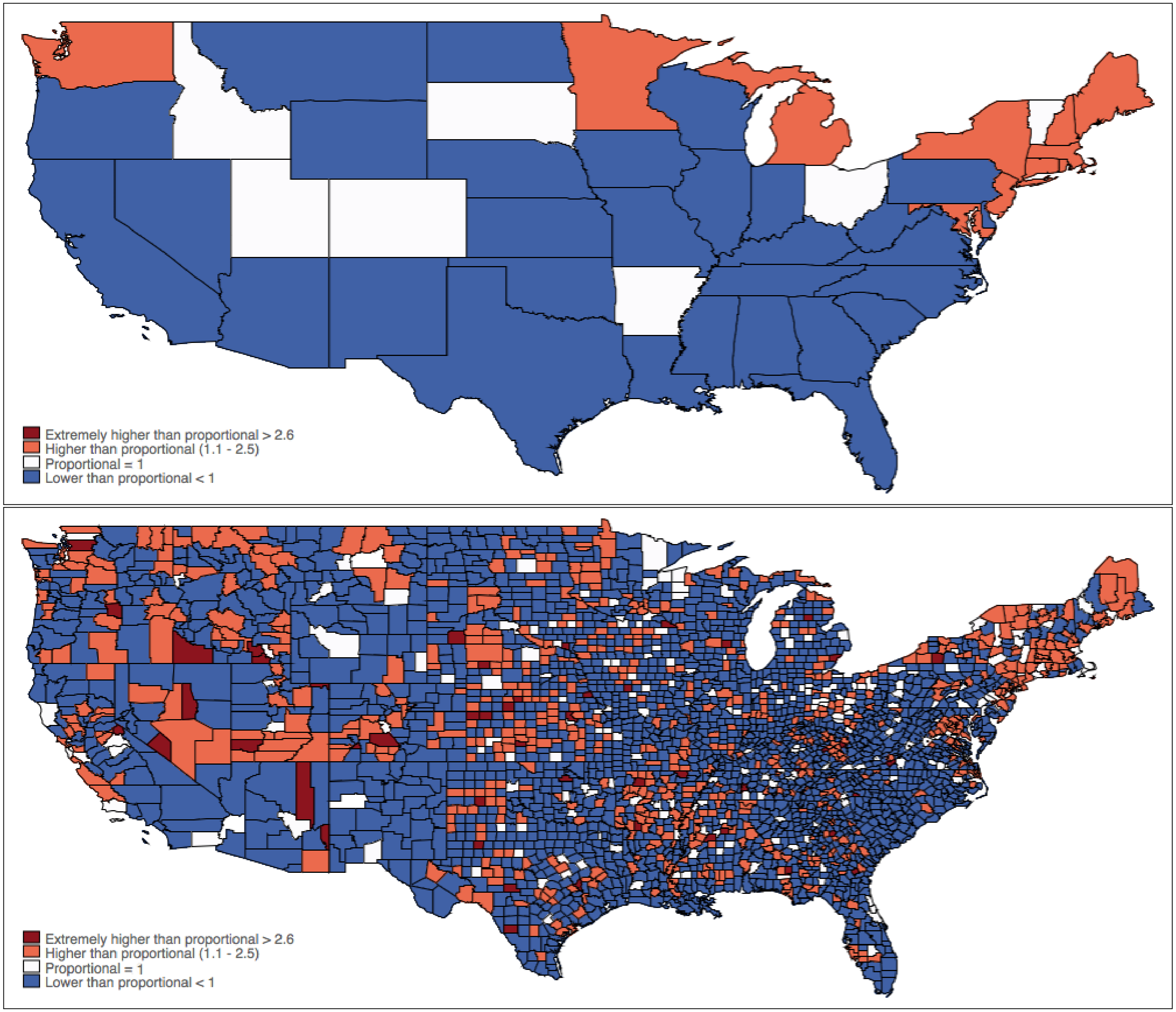
Source: own calculations from US Census data.

Figure 12: Location coefficients by state and county - Elementary Education, 1980



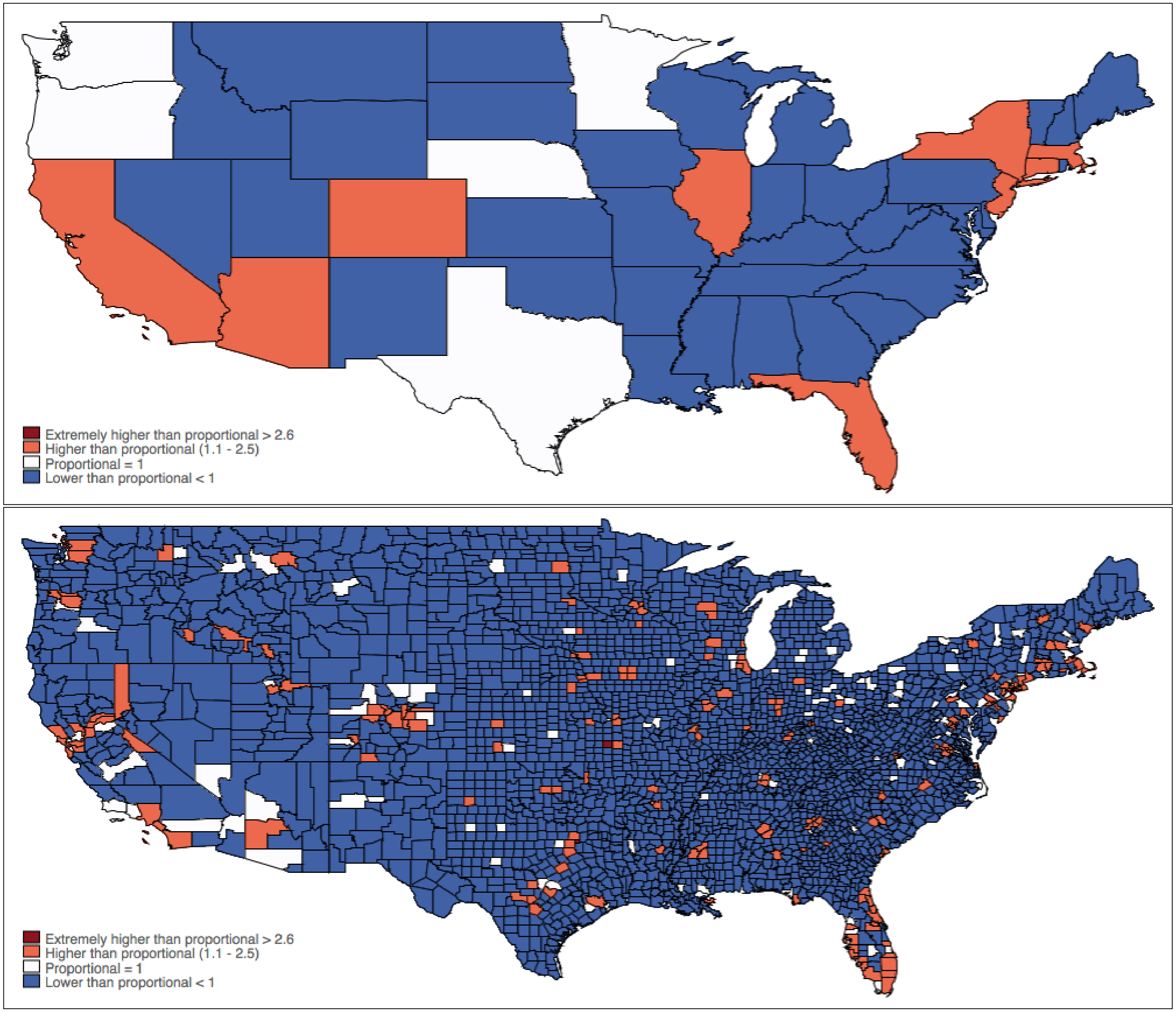
Source: own calculations from US Census data.

Figure 13: Location coefficients by state and county - Other Education, 1980



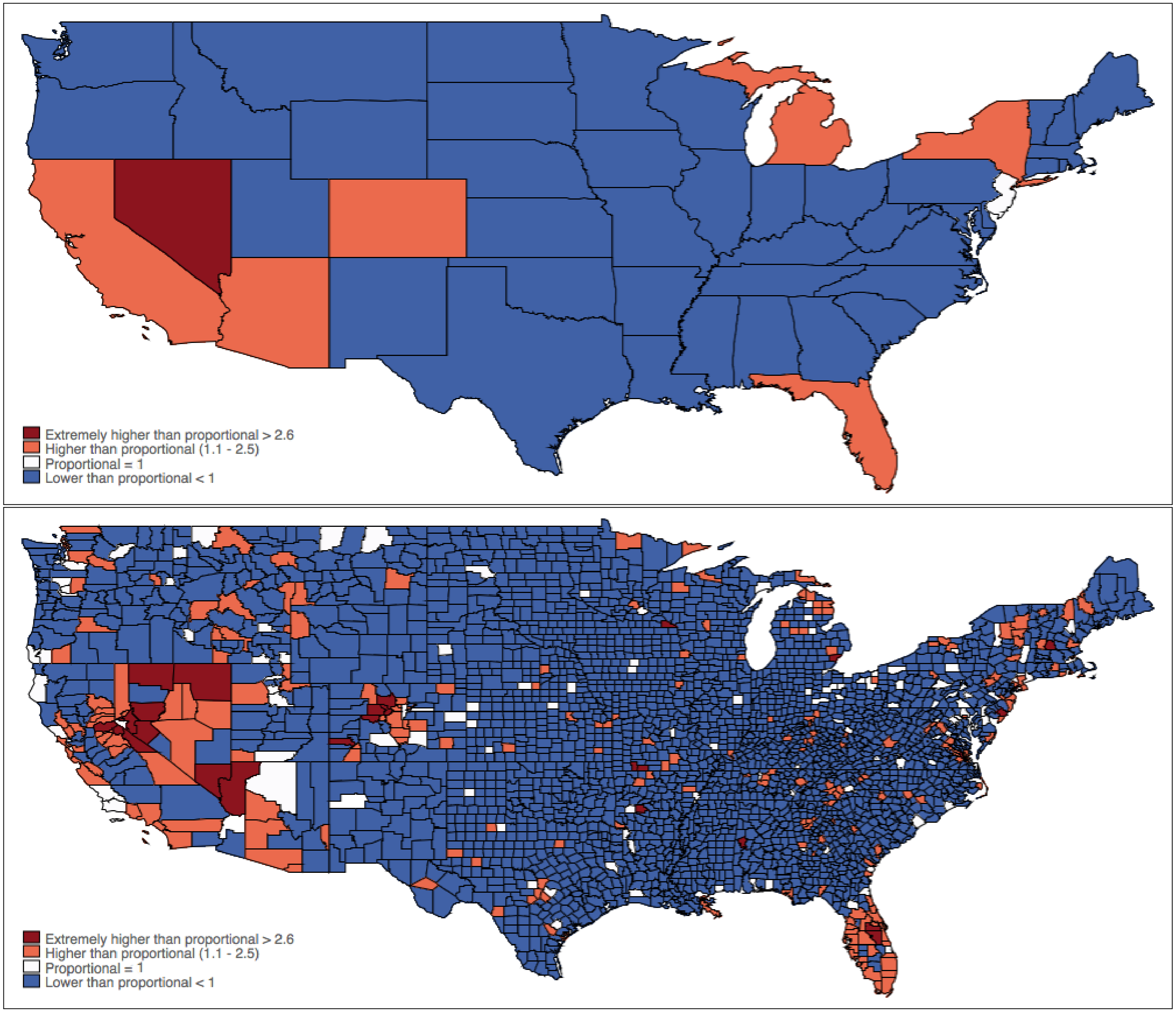
Source: own calculations from US Census data.

Figure 14: Location coefficients by state and county - Insurance, 1980



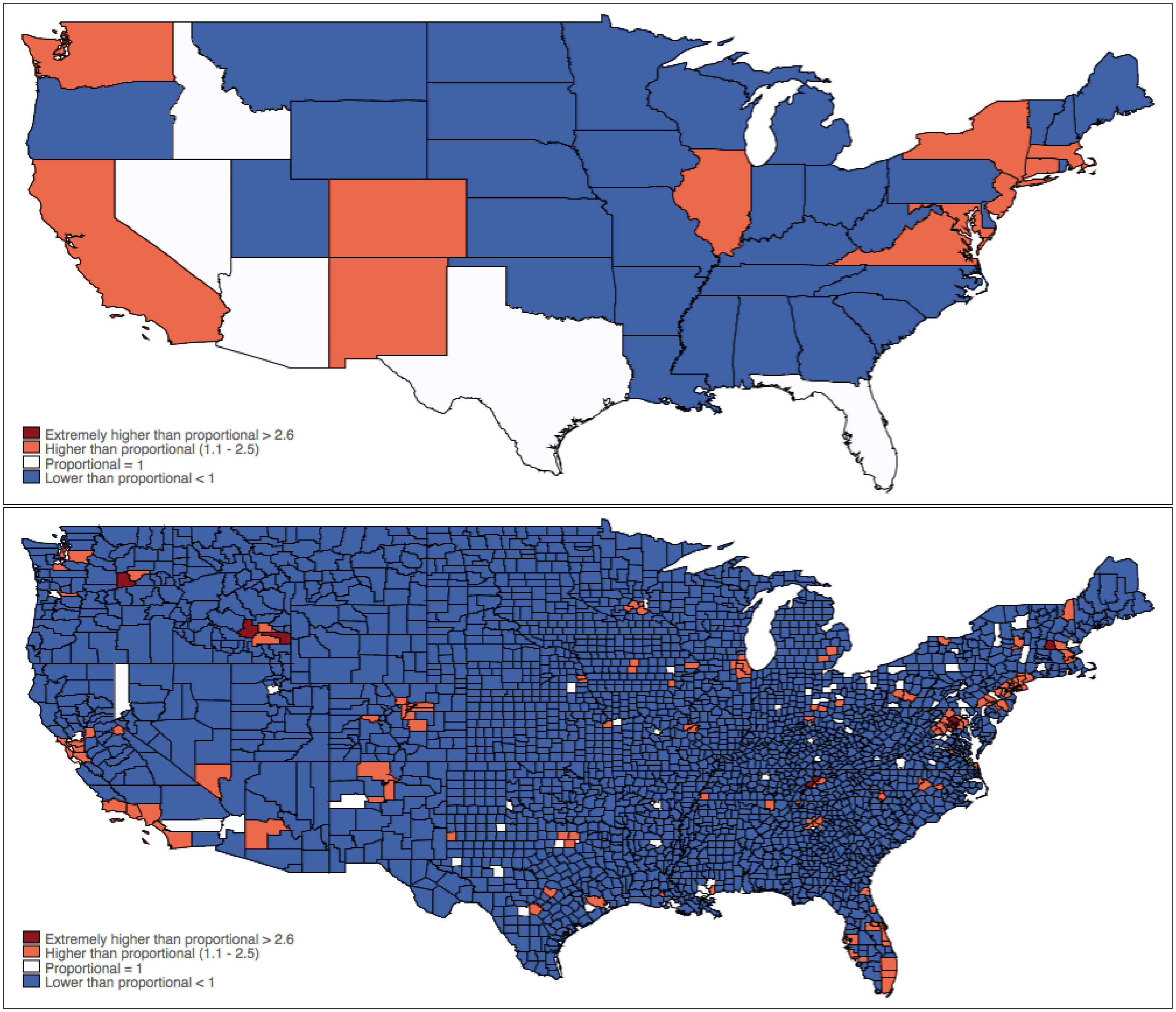
Source: own calculations from US Census data.

Figure 15: Location coefficients by state and county - Entertainment, 1980



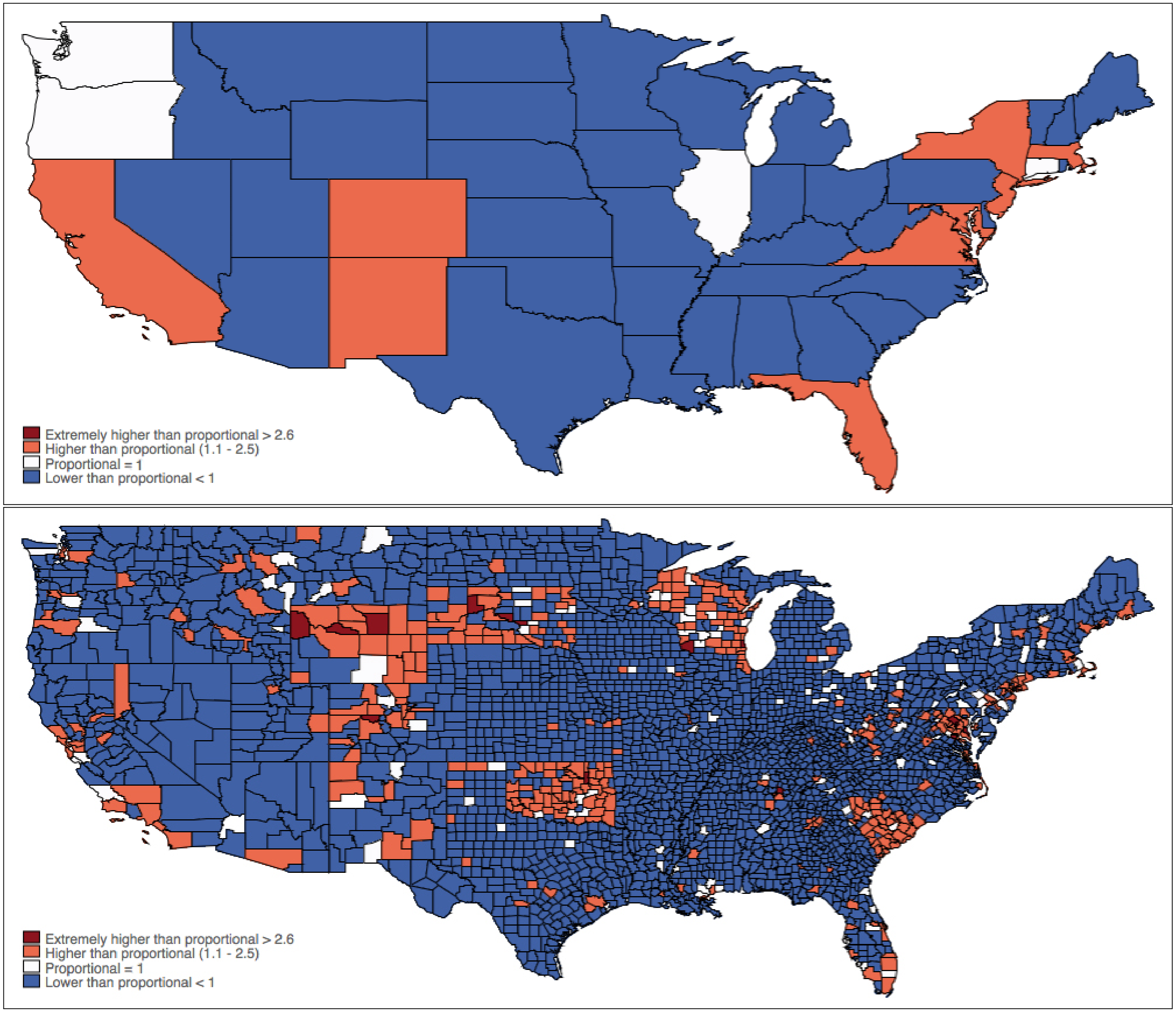
Source: own calculations from US Census data.

Figure 16: Location coefficients by state and county - Business Services, 1980



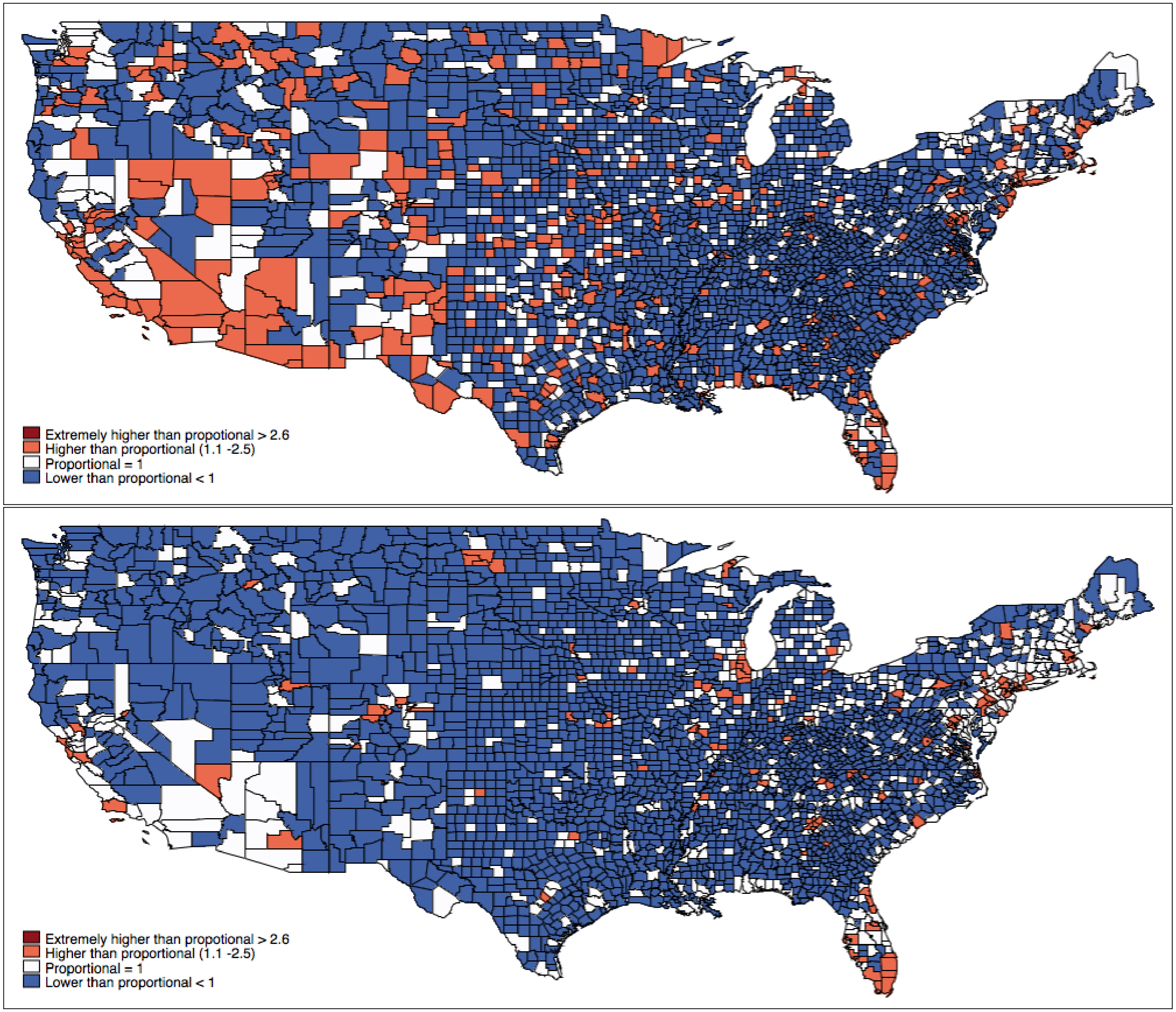
Source: own calculations from US Census data.

Figure 17: Location coefficients by state and county - Professional Services, 1980



Source: own calculations from US Census data.

Figure 18: Location coefficients by county - KIBS, 1950 and 2010



Source: own calculations from US Census data.

F Sources, methods and calculations for Market Potential and Distance-Weighted Total GDP sum

The concept of Market Potential has been derived from the framework of geographers and used on several occasions as a measure of comparison of market size of different regions based on its location. It considers the potential demand that could arise from trading partners weighed by the economic distance to the subject location. This research also relies on the Distance Weighed Total GDP sum which is, in practice, computed in the same way.

The 30 countries used as trading partners of the US are based on the top importers on each benchmark years reported by the World Trade Organization and on the historical data availability on GDP obtained from Maddison [2010].[4] Mayer and Zignago [2006] provide information on the geodesic bilateral distances from counties to each of the countries that are used as commercial partners of the US. The latitudes and longitudes of the centroid of each polygon on all US counties and its area are available from and US Census Bureau. A dummy variable for county coasts was built to account for international transportation costs and was obtained following the criteria of the National Oceanic and Atmosphere Administration of the USA Department. Bilateral distances have been obtained from latitude and longitude coordinates available from TIGER (US Census Bureau).

GDP by state for the years 2010, 1980, 1950 and 1930 have been obtained from the original records of the Internal Revenue Service, that hold the original documents from Statistics of Income reports for 1930, 1950 and 1980 and from the Bureau of Economic Analysis for 2010. These original data were presented in nominal dollars and had to be transformed to real dollars using CPI deflator calculations from Bureau of Labor Statistics.

[4] Argentina, Australia, Belgium, Brazil, Canada, Colombia, Cuba, Denmark, Finland, France, Germany, Greece, India, Ireland, Italy, Japan, Malaysia, Mexico, Netherlands, Philippines, Poland, Portugal, Spain, Switzerland, Taiwan, United Kingdom, Venezuela and, since 1950, Israel, Singapore and South Korea.

Additionally, the transport costs structure has been derived from the information presented in several sources. International transport costs have been obtained from the long-term evolution presented in Mohammed and Williamson [2004] and Jacks et al. [2008], the average bilateral costs presented by Golub and Tomasik [2008] for bilateral trade costs between US and OECD countries. Internal transport costs have been obtained from the data presented by Harris [1954] and the Statistical Abstracts for each year's economic census.

The cost structure has been calculated as an ad-valorem tariff equivalent that follows this structure:[5]

Table 12: Trade costs

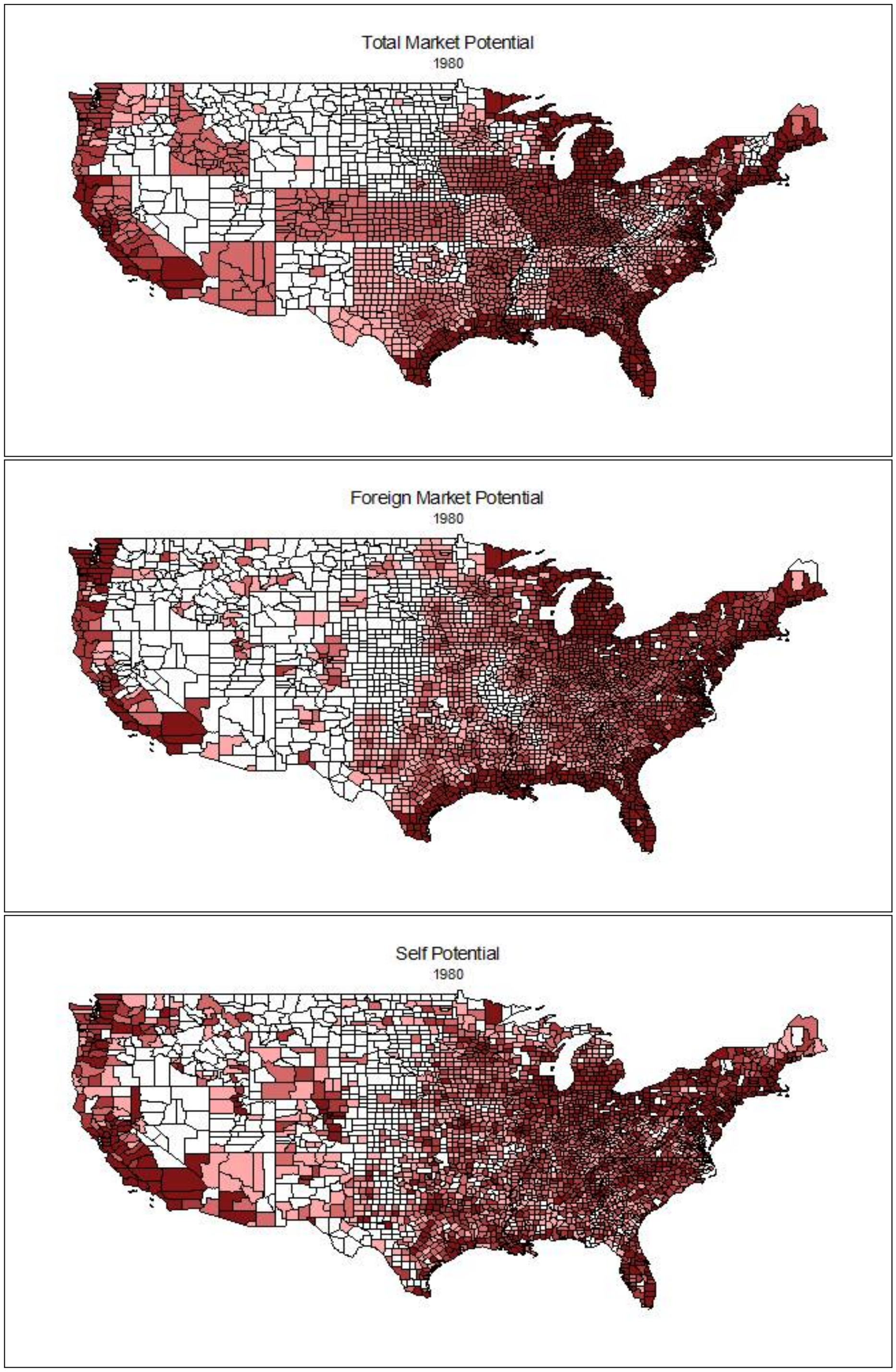
	1930	**1950**	**1980**	**2010**
INTERIOR				
Trucking				
0-80 Kms	0.037	0.029	0.017	0.004
80-160 Kms	0.049	0.039	0.023	0.006
160-480 Kms	0.061	0.049	0.029	0.007
480-708 Kms	0.109	0.087	0.052	0.013
Railroads				
708-1780 Kms	0.139	0.136	0.119	0.102
more than 1780 Kms	0.215	0.223	0.196	0.168
INTERNATIONAL	0.292	0.365	0.156	0.146

Ad-valorem tax-equivalent per potential transported dollar. *Source: see text.*

Market potential between international trading partners and counties has been obtained by designating domestic nodes as Market Potential calculations are usually done (Martínez-Galarraga [2014] and Missiaia [2014]). In this case, the procedure is closer to the one followed by Jacks et al. [2008], by choosing closest distance from each county to any of the top 100 biggest cities from 1930 to 1980 or the Standard Statistical Metropolitan Areas in 2010 as the most probable connection of trade.

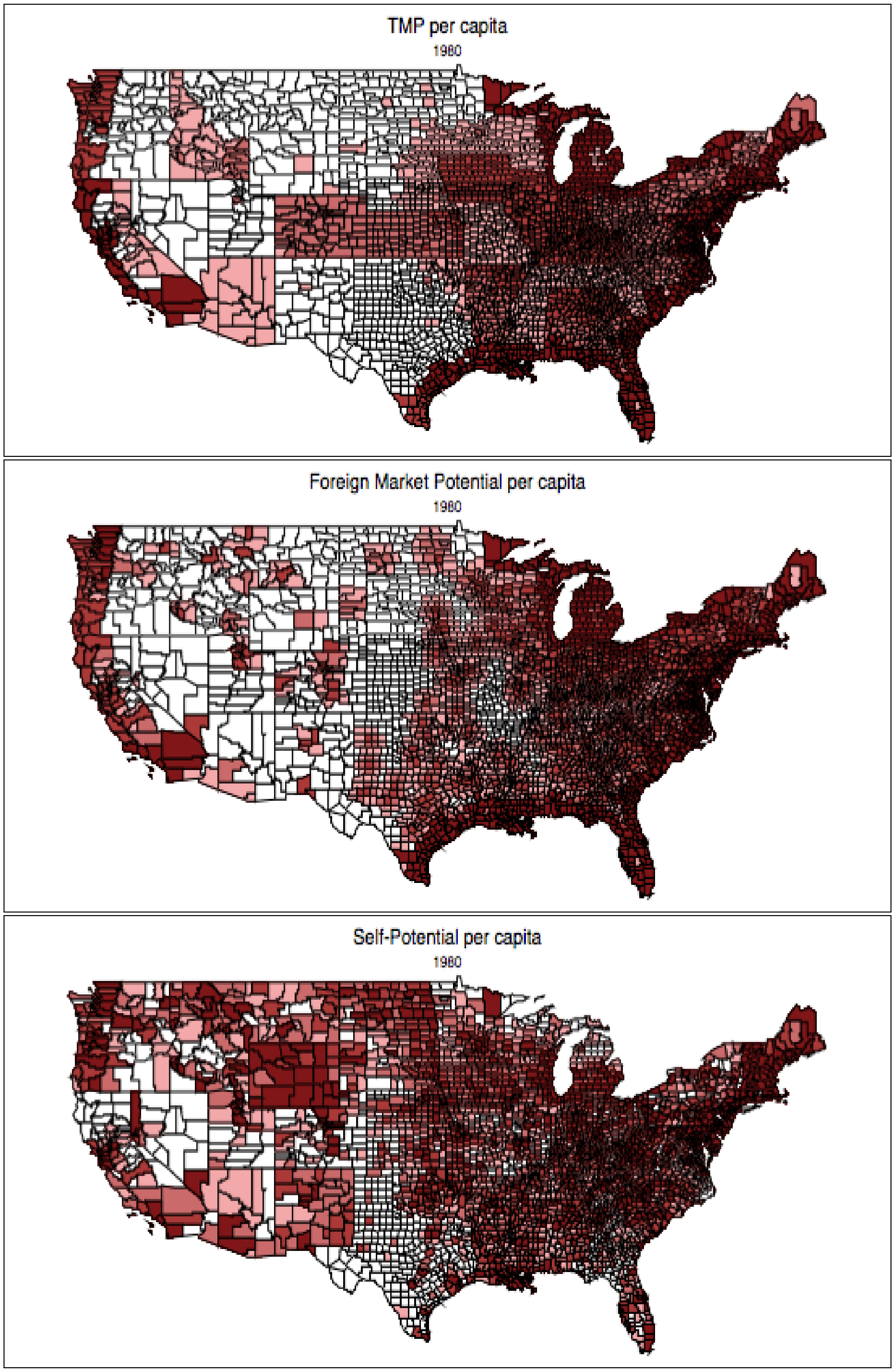
[5]Golub and Tomasik [2008] show that the cost of transportation by kilogram of goods transported is very similar to the cost of transportation by dollar.

Figure 19: Market Potential components, 1980



Source: from author's own calculations.

Figure 20: Per Capita Market Potential components, 1980



Source: from author's own calculations.

G HO and MP regression control tests

Table 13: Determinants of production with interactions

Variable	Primary	Secondary	Tertiary	Personal	KIBS
Land	8.258	-0.035	-0.500	-0.207	-0.611
	(5.926)	*(0.590)*	*(0.546)*	*(0.277)*	*(0.572)*
Agrarian	-1.691	0.226	0.227		
	(1.331)	*(0.240)*	*(0.085)*		
Artisans	-5.917	-3.667	4.555*	1.160	6.277**
	(24.714)	*(3.630)*	*(1.980)*	*(0.900)*	*(2.266)*
Unskilled	-45.146*	9.145***	1.492	0.309	-7.191*
	(19.717)	*(2.474)*	*(2.161)*	*(0.911)*	*(3.180)*
Professionals	32.563	-3.739	-2.304		
	(17.779)	*(3.421)*	*(2.230)*		
Clerical	7.453	-0.813	-1.979***		
	(5.131)	*(0.770)*	*(0.516)*		
Capital Stock	9.250	-1.751	-1.892		
	(24.986)	*(2.185)*	*(1.643)*		
Capital*Professional				-13.704	40.405**
				(12.800)	*(17.037)*
Capital*Clerical				-10.403	-45.589**
				(18.779)	*(13.897)*
Clerical*Professional				15.000	18.430
				(12.902)	*(10.451)*
log TOTAL MP	-0.371***	0.041**	0.021***	0.029***	0.021***
	(0.072)	*(0.013)*	*(0.005)*	*(0.004)*	*(0.006)*
Constant	8.997***	-0.180	0.398***	0.207**	0.445***
	(1.257)	*(0.276)*	*(0.078)*	*(0.083)*	*(0.113)*
r-squared	0.24	0.15	0.11	0.05	0.15
N	11918	11423	11933	9272	12294

Dependent variable: Hoover's index of localization by county. Independent variables: proportion of factor endowments by state and log of Total Market Potential by county. Coefficients from two-way fixed effects regression. Standard errors in brackets under the coefficients, where (*), (**) and (***) correspond to significantly different from zero coefficients at 10%, 5% and 1% confidence level. *Source: own calculations from US Census data.*

Table 14: Heckscher-Ohlin and Local Market Potential

Variable	**Primary**	**Secondary**	**Tertiary**	**Personal**	**KIBS**
Land	4.528	-0.269	0.043	0.027	0.428
	(4.273)	*(0.523)*	*(0.424)*	*(0.357)*	*(0.558)*
Agrarian	-0.123	0.092	0.147	0.302	
	(2.054)	*(0.270)*	*(0.125)*	*(0.213)*	
Artisans	0.905	-2.217	2.885**	1.605	4.677***
	(17.731)	*(4.178)*	*(1.219)*	*(1.410)*	*(0.954)*
Unskilled	-29.274	7.359	0.772	-0.423	-7.08***
	(31.693)	*(4.301)*	*(2.712)*	*(1.086)*	*(2.041)*
Professionals	14.370	-3.029	-0.695		
	(23.032)	*(4.258)*	*(2.618)*		
Clerical	-1.041	-0.737	-0.991***		
	(7.196)	*(1.252)*	*(0.276)*		
Capital Stock	20.974	-2.451	-2.840**		
	(18.270)	*(2.500)*	*(1.175)*		
Capital*Professional				-36.517	26.636
				(18.965)	*(22.182)*
Capital*Clerical					-39.603**
					(19.056)
Clerical*professional				20.189**	29.796**
				(8.686)	*(11.189)*
Log Self-Potential	-1.176***	0.087***	0.090***	0.078***	0.120***
	(0.174)	*(0.017)*	*(0.010)*	*(0.010)*	*(0.010)*
Constant	18.855***	-0.653*	-0.508***	-0.473**	-0.870***
	(2.249)	*(0.294)*	*(0.144)*	*(0.145)*	*(0.177)*
r-squared	0.46	0.18	0.22	0.17	0.29
N	11898	11403	11913	8940	12269

Dependent variable: Hoover's index of localization by county. Independent variables: proportion of factor endowments by state and County Local Market Potential. Coefficients from two-way fixed effects regression (year and division). Standard errors in brackets under the coefficients, where (*), (**) and (***) correspond to significantly different from zero coefficients at 10%, 5% and 1% confidence level. *Source: own calculations from US Census data.*

Table 15: IV regression results with HO and MP

Variable	**Primary**	**Secondary**	**Tertiary**	**Personal**	**KIBS**
Land	4.670***	-0.040	-0.748***	1.138***	0.320
	(1.724)	*(0.295)*	*(0.202)*	*(0.174)*	*(0.263)*
Agrarian	-2.813***	0.837***	0.419***	0.178**	-0.146
	(0.848)	*(0.141)*	*(0.103)*	*(0.082)*	*(0.133)*
Artisans	28.526**	-1.002	2.328*	-1.544	-5.860***
	(11.224)	*(1.928)*	*(1.200)*	*(1.046)*	*(1.770)*
Clerical	-1.350	-0.980	-1.967***	1.313***	4.055***
	(3.792)	*(0.753)*	*(0.474)*	*(0.406)*	*(0.781)*
Professionals	9.487	-7.286***	-4.652***	5.821***	4.739***
	(9.598)	*(1.492)*	*(1.073)*	*(0.866)*	*(1.144)*
Unskilled	-61.855***	15.030***	7.101***	-3.066***	-6.148***
	(9.032)	*(1.760)*	*(1.165)*	*(0.973)*	*(1.449)*
Capital Stock	28.826***	-7.156***	-2.625***	-3.794***	2.152***
	(5.800)	*(0.873)*	*(0.557)*	*(0.521)*	*(0.811)*
Log TMP	-0.958***	0.079***	0.046***	0.058***	0.067***
	(0.028)	*(0.006)*	*(0.003)*	*(0.003)*	*(0.005)*
Constant	26.591***	-0.653***	-0.294***	-0.419***	-1.002***
	(0.688)	*(0.136)*	*(0.082)*	*(0.074)*	*(0.106)*
r-squared	0.30	0.20	0.19	0.09	0.04
N	8832	8838	8843	8835	8779

Dependent variable: Hoover's index of localization by county. Independent variables: Logarithm of Market Potential by county, Shares of HO factors of production. Instruments: Logarithm of Foreign Market Potential and lagged Shares of HO mobile factors of production. Coefficients from IV regression with year and region fixed effects, where (*), (**) and (***) correspond to significantly different from zero coefficients at 10%, 5% and 1% confidence level. Standard errors clustered by region reported under the coefficients. *Source: own calculations from US Census data.*